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PC MAGAZINE

INDUSTRY INSIGHT

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IBM's Laser: $1,495 Wonder

LAB NOTES

Hidden Treasure: How to Get the Most from High Memory

FREE UTILITY

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MAY 26, 1986 THE INDEPENDENT GUIDE TO IBM-STANDARD PERSONAL COMPUTING VOLUME 5, NUMBER 10

Survival Guide

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Market Survey and Ten-Year Growth Plan

EXECUTIVE SUMMARY

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resulting from a series of focus g
conducted by the market research fi
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our track record in the freight arena
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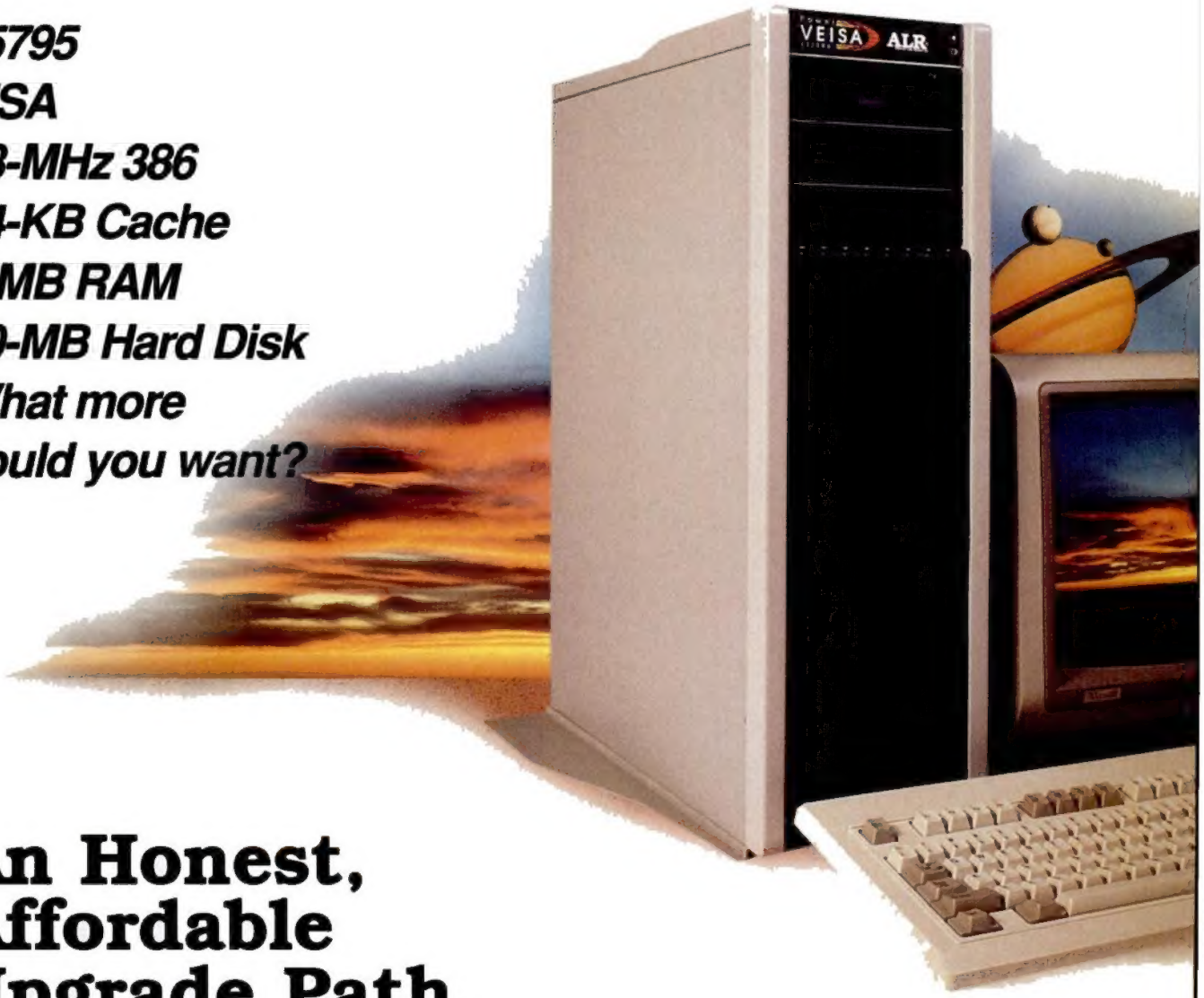

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Inside

When the specifications of the dual-processor Compaq Systempro file server became public, they were met with confusion. Was it a PC? Not exactly. Was it a mini? Well, no, you couldn't say that either.

What it was, quite simply, was the first glimpse of the future of ultra-high-performance PC-based networks.

In order to find out just how fast LANs could be, and to discover if a LAN could beat a minicomputer at its own game, we brought back the multiuser accounting software benchmark tests we developed for last September's LAN issue.

Price Waterhouse Consulting Manager Ray August and *PC Magazine*'s senior editor of west coast operations, Lee Thé, headed for PC LAN Labs. There, workgroup systems editor Frank J. Derfler, Jr., and project leader Randol Tigrett set up all kinds of hardware/LAN operating system combinations in which a Systempro, as well as other EISA, MCA, and multiprocessor machines, figured prominently.

Ardent LAN fans: Price Waterhouse's Ray August with *PC Magazine*'s Lee Thé, Randol Tigrett, and Frank Derfler at PC LAN Labs.

With the help of three of the accounting software vendors who participated in last fall's testing, the LAN Labs team ran an unprecedented series of real-world benchmark tests.

When LAN Labs testing was finished, the team traveled to DR Labs at the offices of our sister publication, *Digital Review*. There, a DEC mini waited to be benchmarked with the same accounting tests and software. How did the LANs compare?

Well, remember, you're reading *PC Magazine*, and we expected well-designed LANs to perform admirably, but we had no idea they'd perform *this* admirably. Turn to our feature story "Can LANs Beat Minis?" and see for yourself.

This forward-looking issue also includes a close inspection of three multiprocessing machines: the Systempro, the Mitac Series 500, and the NetFrame NF100, computers we came to call "genuinely interesting servers." We have also gathered the latest in 32-bit MCA and EISA adapter cards to show you how widening your data paths will help the rest of your LAN keep up with your hot new server.

And then there's software. We've prepared evaluations of the latest versions of 17 LAN operating systems, including dedicated systems like *NetWare 386* and low-cost DOS-based sytems like *LANtastic*.

And contributing editor Alfred Poor tells you how to make your LAN share printers effectively. That's what you bought it for in the first place, right?

Dig in, because as workgroup systems editor Derfler is fond of saying, "If you're not connected, you're not computing."—**Donald P. Willmott** ■

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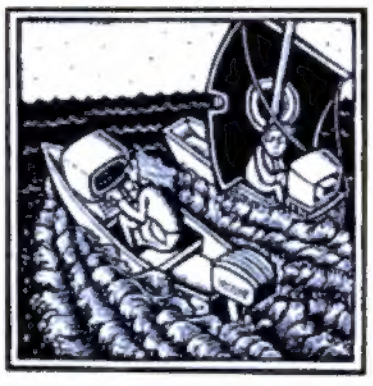

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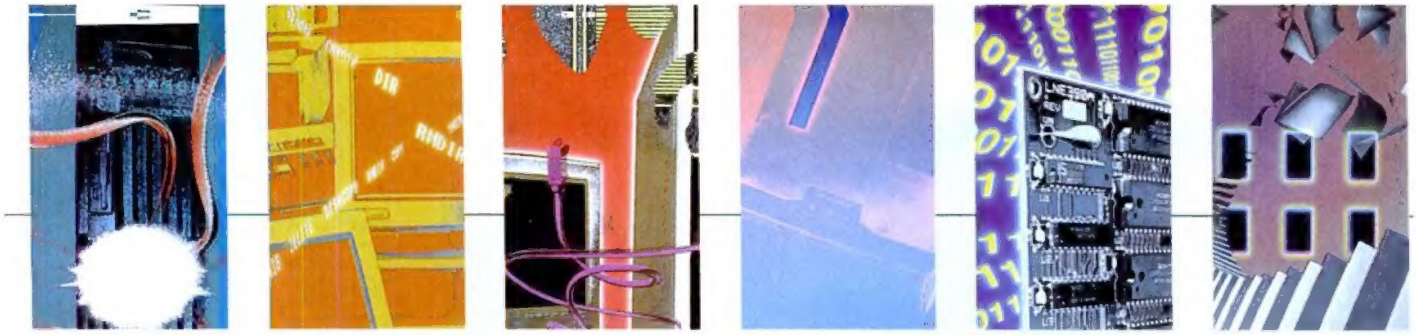

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1-30-90

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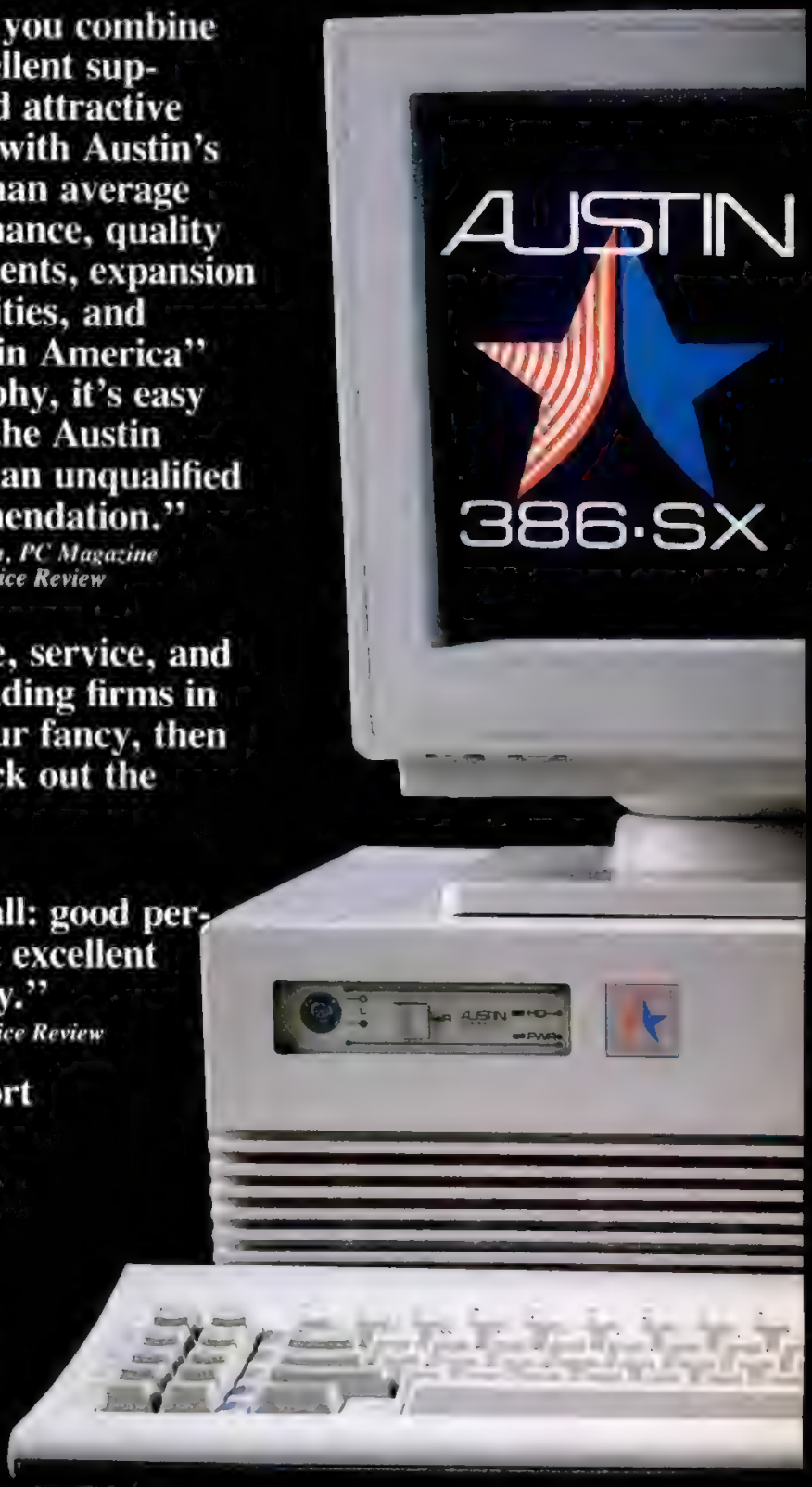
Bruce Brown, PC Magazine Editor's Choice Review



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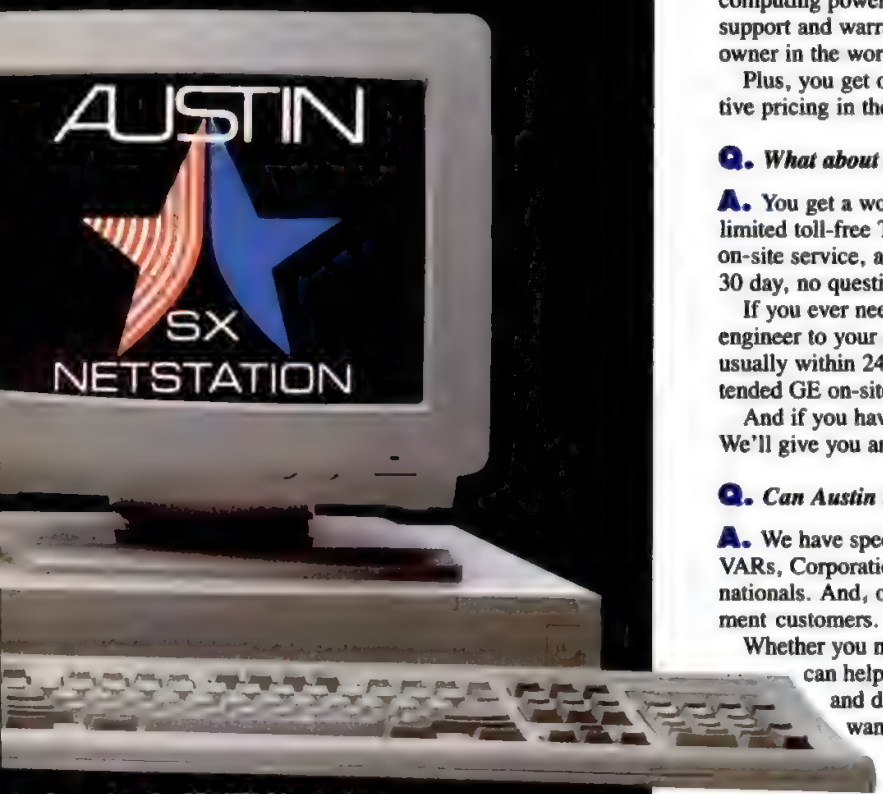

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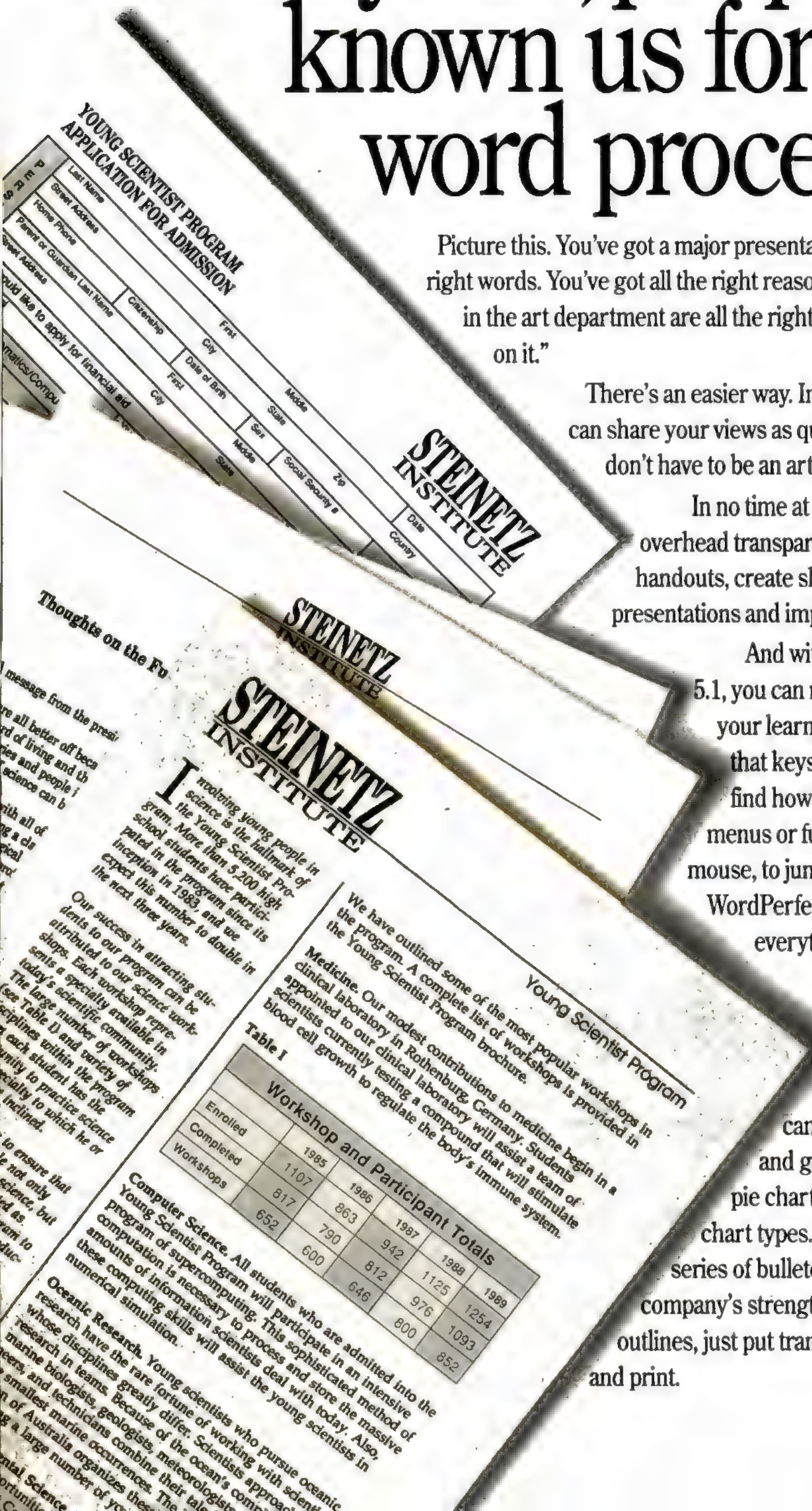

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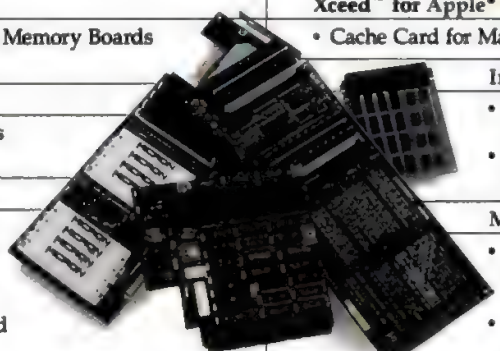

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Letters

A FAN OF THE PAPER-WHITE SCREEN

I have just finished reading the February 13, 1990, issue of *PC Magazine*. I especially enjoyed the article "Now Showing on the Big Screen" by Alfred Poor.

Mr. Poor has done a more in-depth review of the DTP/CAD paper-white monitors than you or anyone else has previously published. I particularly appreciate his including the dots per inch, active display size, weight, length of monitor cable, and benchmark tests. Also, the article was topped off nicely with subjective impressions by the reviewers. I particularly appreciated the comments on the quality of application software drivers for each monitor.

I'll be looking forward to future reviews of the next generation of CAD monitors, especially if you handle it with the same skill as you did this latest one.

Scott C. Lewis
Bryan, Texas

CASE REOPENED

I enjoyed reading "CASE Tools for Designing Your Applications" in the January 30, 1990, edition of *PC Magazine*. I found a lot of useful information regarding the CASE marketplace, and I felt a number of major issues were addressed.

However, I do want to point out one item of omission. The article stated that *Foundation* from Andersen Consulting is not available without consulting services. This is not the case. *Foundation* has been available as a product set for over two years.

Glover T. Ferguson, Jr.
Director of *Foundation* Development
Andersen Consulting
Chicago, Illinois

A HELPING HAND FOR THE HANDICAPPED

I am responding to "PCs and the Handicapped," Bill Machrone's article in the January 30, 1990, issue of *PC Magazine*. These thoughts come from the perspective of a person with a disability, a rehabilitation professional working in placement who was formerly a systems analyst.

CAD and desktop publishing prove color isn't everything.

The successful developer provides power and ease of use for us all. Developing standards for hardware and software accessibility will lower costs, develop an untapped market, maximize the independence and employability of people with disabilities, and enrich everyone as a result. Government estimates measure the population of Americans with disabilities to be in the neighborhood of 38 million. Developing that market will provide a lot of revenue.

Why don't industry movers and shakers unite and design operating system extensions that provide standard hooks for adaptive I/O? Let well-behaved software use these hooks, empower these users, and reap the market-share benefits. Make these extensions a part of MS-DOS, OS/2, Unix, and the Macintosh OS.

Enhancing and maintaining accessibility to users with visual impairments is a multifaceted issue. Can a standardized screen driver synchronized with speech software and its macro capabilities (making documentation, menuing, and on-line help accessible) be developed? Remember, it doesn't have to look good. It has to work effectively with adaptive I/O.

The industry has enhanced my productivity dramatically, simply by developing and marketing good, useful tools. Targeted system and product development can enhance the lives of other potential users even more dramatically.

Phil Dacey
Boston Computer Society
Boston, Massachusetts

Many thanks for Bill Machrone's column on PC access for the disabled in the January 30, 1990, issue. As the producer of a keyboard emulator program for quadriplegics, we welcome the plea to Microsoft to make *Microsoft Windows* 3.0 and other graphics environments more accessible to developers in this market.

We find it unfortunate, however, that the column focused on a product (the Prab/Zenith robotic workstation) that retails for $50,000. This could lead some readers to the incorrect conclusion that all such adaptations for the disabled are prohibitively expensive. They're not; in fact, our own system, which gives quadriplegics access to the DOS and Macintosh environments, costs just $1,395.

Larry Lewack
National Sales Manager
Pointer Systems Inc.
Burlington, Vermont

PC MAGAZINE Pointer Systems markets an infrared optics headband known as the FreeWheel that connects to the serial port on your computer. In addition, the company bundles its *FreeBoard* software, which is an on-screen, windowed keyboard overlay that works with FreeWheel or any standard pointing devices to permit data entry without a keyboard. FreeWheel with the bundled *FreeBoard* software sells for $1,395. Pointer Systems Inc., Burlington, Vermont; (802) 658-3260.—*Ed.*

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Letters

A TAXING SITUATION

As an accountant I have been looking for information on doing my own personal taxes, both federal and state. I have searched through several computer magazines to find the one that would most suit my needs. It was not until I received my February 27, 1990, issue that I found what I needed in the After Hours section—the first of a two-part series on tax programs.

However, I feel that your timing stinks. That information should be out in early December so the product can be on hand and in use at this time. Maybe next year you can be a little more timely.

Dale Stark
Linden, Virginia

A MAINFRAME FOR ALL SEASONS

William F. Zachmann's opinion in his column ("Mainframe Machismo," *PC Magazine*, February 13, 1990) that "the legions of mainframe diehards have learned nothing and forgotten nothing... [but] history will surprise them" is the kind of micro mindset that will surprise him if his opinion becomes reality. What Mr. Zachmann forgot in his analysis of the mainframe future is the delicate operations that are currently being performed on a mainframe. These operations require fully redundant systems, mirrored storage, large file repository, and the power to fetch, compute, and store the results in a centralized location for distribution.

What if your nonredundant micro/mini world failed at the time you wanted to withdraw money from your ATM? Too bad, micro man! What if there were nonmirrored disks on your micro/mini when you wanted to sell a bunch of stocks and couldn't because you had to wait for the data to be restored?

Mainframes are here to stay. If you don't believe it, look around you.

Gary L. Brown
Syracuse, New York

Regarding William F. Zachmann's comments in *PC Magazine*'s February 13, 1990, issue, I've always thought "mainframes" rhymed with "maintenance fees." Workstation vendors can also be included as having a "mainframe" mentality. Even after you buy/lease them, the vendor's required maintenance fees bleed you on a monthly basis.

386-based PCs need to catch up by having an efficient 32-bit operating system with 32-bit applications software to match. Then workstations will also become mainframe dinosaurs.

Jeff Epstein
Pomona, California

MICROSOFT MISDEMEANOR

I was shocked to find out that Microsoft had decided not to provide a complete set of manuals with its latest product, *Word for Windows*. I am referring to the *Technical Reference Manual*. In plain English, it's the reference manual for the macro programming language.

Evidently Microsoft believes that after buying a package that lists for $495, you wouldn't have any qualms about paying an additional $20 for the manual. To the best of my knowledge, Microsoft is also failing to inform anyone of this fact until after they have bought the package.

As a matter of fact, the various reviewers have evidently been misinformed (or perhaps misled) by Microsoft since they are stating that the manual is free. I have called Microsoft to see if the manual was indeed free and was informed that the manual was, in reality, $20.

I view it as akin to buying a car and, after delivery, finding out that the keys are an extra option. It's an insult to the buyer.

I can see it now: the next time you purchase a package, everything will be optional, including the diskettes. Five hundred for the package, $45 for the diskettes, $20 if you wish the user manual.

Richard L. Rosenheim
Paradise Valley, Arizona

THE LAST WORD ON WORD PROCESSORS

I have been amused at the letters sent to you regarding your recent article on word processors ("Two Aces and a King: The Big Three Word Processors Raise the Ante," November 28, 1989). The letters imply that a criticism of a word processor, or lack of inclusion of a certain word processor in your analysis, is an insult to the intelligence (prestige?) of the person who is currently using that word processor. I know we feel hurt when someone casts an aspersion against our city, football team, political party, and so on. But our word processor? Come now, don't we have enough reasons for a heart attack without taking software so personally?

John E. Johnson, Jr.
Redwood City, California

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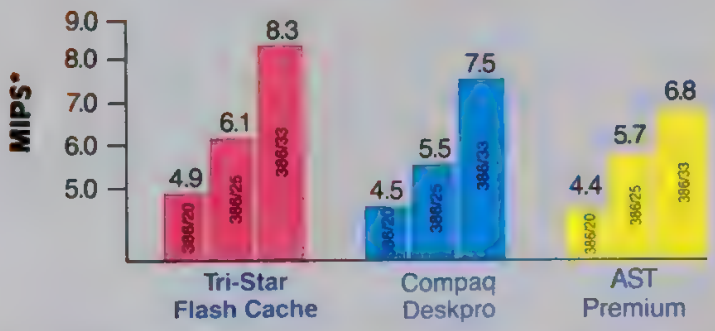

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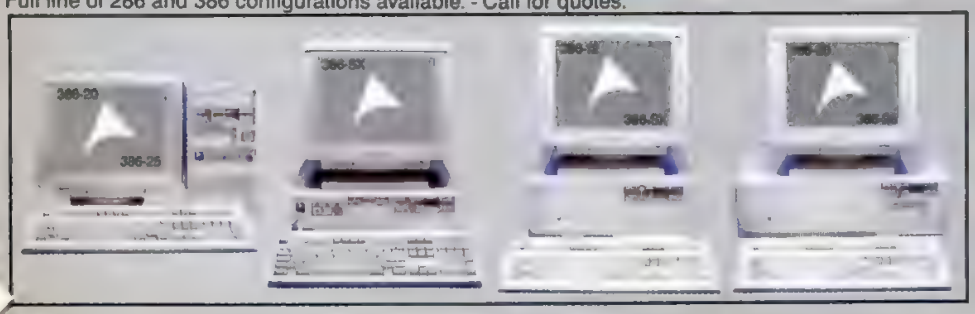

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Letters

AND GUIs, TOO

For months now I've been reading letters from GUI-phobes in *PC Magazine*. Usually these people express themselves as computer literate, willing to learn, and above all, excellent typists. These people seem to dislike graphical user interfaces because they can type faster than they can click, read English faster than they can interpret icons, and are inexorably addicted to the command-line interface. I find myself in a unique position, because I agree with the reasons stated against GUIs, and yet I very much enjoy working under OS/2's Presentation Manager.

Presentation Manager gives the user the option of working at a command prompt within a window on the screen. This is actually more helpful than it sounds. I often refer to information in one window while inputting keystrokes into another. Also, when I am interrupted in my work and need to start another program, it is much faster to create another window in which to launch the new process than it would be to quit the current application. Finally, a mouse/menu-driven system is much faster to learn than a command-driven system, no matter how good you are at reading manuals.

If you are working with a low-power, memory-starved system and you like DOS, then stick with it. However, if you are lucky or rich enough to have a system capable of running OS/2, you might want to give it a chance.

Howard E. Hinnant
Hampton, Virginia

BUILDING THE BETTER KEYBOARD

Your December 12, 1989, feature, "Wanted: More than Just a Replacement," compared and evaluated available keyboards in all respects but one: how well one can type on them. A more meaningful basis of assessment might have been a simple 10-minute typing test repeated by each evaluator, first on a Selectric typewriter and then on each keyboard.

My own impression is that computer keyboards still are being designed by and for those who hunt and peck and who wish to rest their wrists somewhere. The keyboard that came with my IBM PS/2 Model 50 limits me to a rhythm that's about half normal typing speed. Is there some basic reason for this least expensive yet most essential hardware component to have been so degraded in performance relative to an electric typewriter?

A related observation is the incongruity of the computer industry's involvement in education. Instead of developing and promoting inexpensive means of early typing instruction and practice that might enable our schools to prepare a whole generation to partake fully of the blessings of the computer age, the industry instead encourages early exposure of children to "keyboarding," as necessary to make them directly familiar with computers at the earliest opportunity and as distinguished from the redundant expression "touch typing."

This misplaced emphasis has the attendant effect of developing—and leaving an individual cursed with—wasteful hunt-and-peck habits that are unlikely ever to be unlearned. Such placement of the cart before the horse may render greater disservice than good to the child and to society and may also be self-defeating for the industry in the long run.

William R. Pearce
Bethesda, Maryland

CORRECTIONS & AMPLIFICATIONS

In "3-D CADD: Workstation Tools for the PC Platform" (*PC Magazine*, March 27, 1990), the suitability-to-task boxes for *RoboCAD* and *VersaCAD/386* were switched. The scores for each product, however, are correct as shown.

In our evaluation of Apollo Audio Visual's LCD unit ("LCD Panels: 12 for the Road," *PC Magazine*, February 27, 1990), we reported that the Presenter PC9100GS was the most susceptible to blooming of all the units reviewed. Our performance tests showed the exact opposite, and the tests are correct. The unit is the least susceptible to blooming. *PC Magazine* regrets the error.

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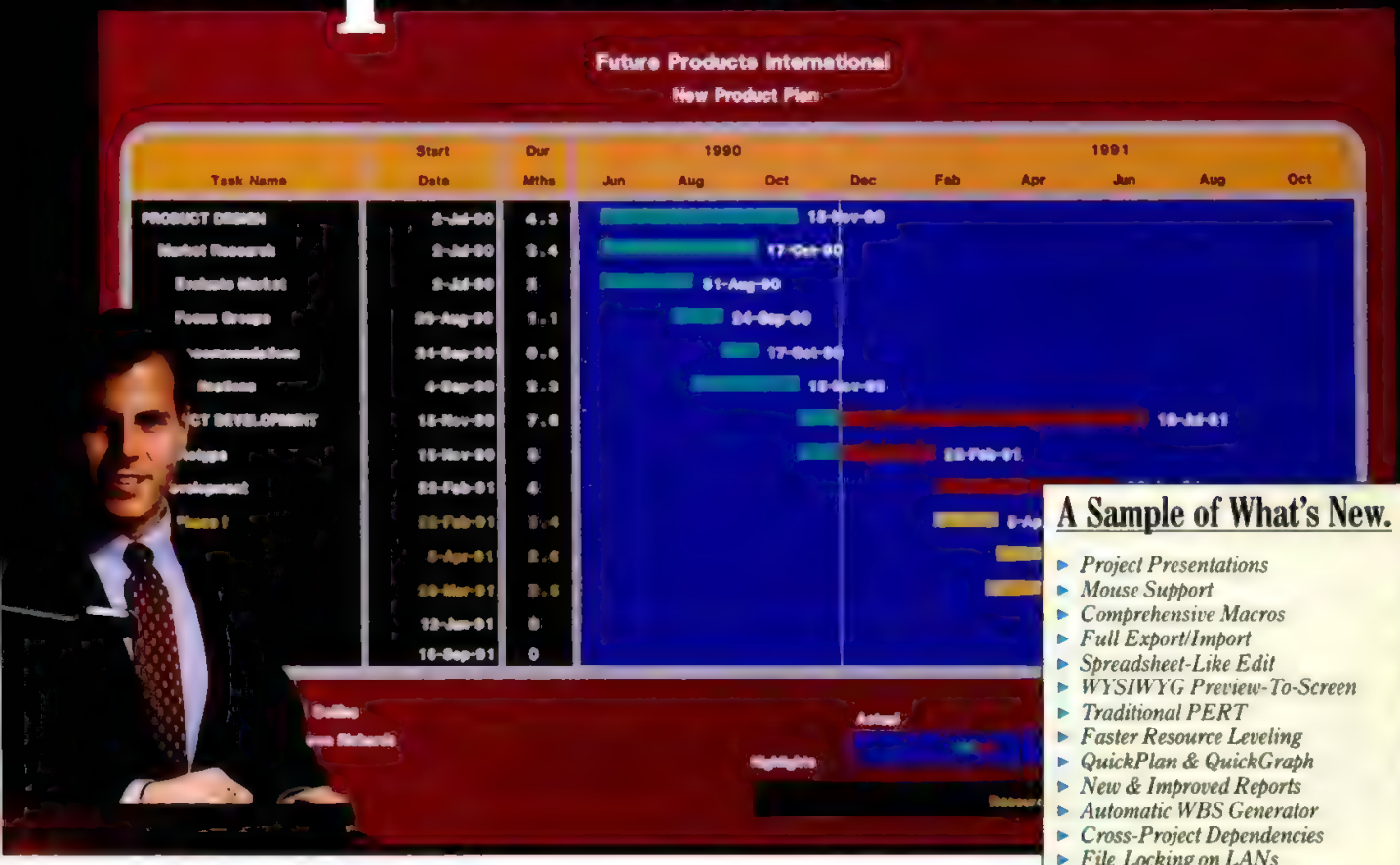

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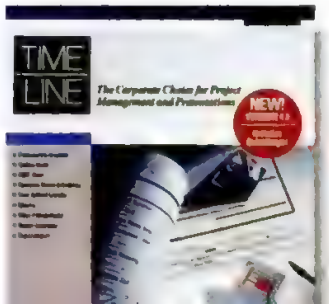

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by Lori Grunin

Advisor

- ALL BOARDED UP: Ways to break the expansion-slot barrier.
- CHARTING THE HARDWARE SEAS: Finding the ideal platform for creating presentation graphics.

ALL BOARDED UP

I'm an expansion board freak who is running out of slots in his AT clone. Before settling for the obvious solution—throwing out a card to make room for a new one—do you know of a bus expansion device that allows me to add more cards?

Gottfried M. Knoll
Eschborn, West Germany

There are different ways to increase the room in your system, including buying an expansion chassis housing extra expansion bus slots.

First, be warned that expansion chassis have a significant drawback: not all cards will work in them, in part because the signal running from the system's bus to the external chassis can distort and reflect. That's why most chassis need an interface card on both ends (one in the main machine and one in the chassis)—to provide signal buffering. In addition, most chassis supply only 8-bit slots. While many boards still use 8-bit interfaces, it's nonetheless something to keep in mind.

Now for the buyer's guide to companies that sell the type of expansion chassis you're looking for. Note that all have their own power supplies.

Burr-Brown Corp. offers a 7-slot (minus one slot for the interface), 8-bit model for $995, plus another $120 for the interface. It can hold up to three half-height devices. (Burr-Brown Corp., 1141 West Grant Rd., MS 131, Tucson, AZ 85705; (602) 746-1111.)

Lightek's ex-Port series has several models, all of which have 8-bit slots and attach to your system via the parallel port. The 3xP has three slots plus room for a 3.5-inch drive ($495); the 5xP has five slots plus bays for two half-height devices ($595). Subtract one slot from each for the interface card, but note that you don't lose a slot in your system. (Lightek, 11000 Three Chopt Rd., Suite B, Richmond, VA 23233; (804) 270-4291.

Personal Computing Tools' XPC 7/200 offers seven free slots with room for three half-height devices ($1,095); the XPC 11/200 has 11 available slots ($1,495). Both run at 8 MHz. (Personal Computing Tools, 17419 Farley Rd., Los Gatos, CA 95030; (408) 395-6600.)

Advanced Digital Corp.'s PC-Exbus adds nine usable slots and runs at 4.77 or 8 MHz ($1,195). 80286- and 80386-based PS/2 system owners who need more slots can also buy ADC's TransFormer2, two interfaces that allow the PC-Exbus to be used wih the PS/2 family. (Advanced Digital Corp., 5432 Production Dr., Huntington Beach, CA 92649; (714) 891-4004.)

PC Horizons' PC-Xtra provides five usable slots ($549); the company also sells a unit with a smaller power supply for $100 less. (PC Horizons, 1710-M Newport Circle, Santa Ana, CA 92705; (714) 953-5396.)

And, finally, Perx is a reseller that offers chassis with 16-bit slots. Its QB101 has five available slots ($895), and the QB102 ($1,395) provides 11 usable slots. (Perx, 1730 S. Amphlett Blvd., #222 San Mateo, CA 94402; (800) 722-7379, (415) 573-0834.)

What are your other options? Well, for one, you could buy a stripped-down, inexpensive XT or AT clone (or build your own) and use it as a slave machine. The story "Building Workgroup Solutions: Zero-Slot LANs" in the April 24, 1990, issue of *PC Magazine*, discusses the software that you'd need to use and gives you an overview of the capabilities you'd get.

Also, SCSI (Small Computer Systems Interface) devices, which haven't yet come into their own but are certainly becoming more common, allow you to daisy-chain. So for instance, you could conceivably connect a SCSI-driven tape backup to your SCSI-driven CD-ROM drive, at the expense of only one slot.

CHARTING THE HARDWARE SEAS

I own an IBM XT and am considering purchasing either a 286- or 386-based system. I primarily use software such as *Harvard Graphics*, *Freelance Plus*, *Graphwriter II*, etc. What hardware features should I consider important for improving the speed of my computer graphics capabilities? To be specific, should I just consider the 386-based system? Will increased clock speed, interleaved memory, shadow RAM, etc., significantly improve my throughput?

Joseph P. Moffa
Las Vegas, Nevada

Several variables affect graphics creation and output speed in general, and to see where your setup could use the most improvement, let's first see what the software does and how hardware influences the speed at each step.

First, of course, you load the program. Then you either import data and text or enter it from within the package. The speed of these processes is governed by the CPU and the hard disk. Next, while you crunch through the layout of the slides, the computer crunches through the calculations required to create them, and displays them on your monitor. The CPU speed is the primary determinant, with the display subsystem (VGA card and monitor) and hard disk speeds secondary contributors. Saving and retrieving slides are disk-intensive operations.

Since the CPU plays such a large part in all of these tasks, it's pretty clear that

your single most effective way of increasing throughput is to go to a more powerful processor with a higher clock speed, such as a 386SX or better. You should notice an immediate increase in performance by merely switching machines. (Reviews of such systems appear in the January 30, 1990, August, 1989, and May 30, 1989, issues of *PC Magazine*.) A math coprocessor—if your package supports one—can also give your CPU a hand.

As for the next most important feature, the hard disk, more-powerful machines generally come with faster hard disks, and something in the sub-30-millisecond range should be quite acceptable for your needs. When reading the *PC Labs* DOS File Access benchmark test results, note that "Small Records" refers to 512-byte and 4K files, while the "Large Records" are 16K and 32K big. When evaluating the respective machines and their drive subsystems, keep in mind these sizes relative to the file sizes produced by your graphics package.

Also, once you have your faster hard disk, you can help to keep it running at top speed by regularly defragmenting it. Fragmentation occurs because DOS needs to break files up into pieces in order to write them if it can't find enough contiguous sectors. When you retrieve those files, DOS then has to pull all the pieces together, necessitating a greater number of seeks and subsequently slowing down retrieval.

FastTrax, Version 3.9 ($49.95), is a standalone disk defragmenter (Bridgeway Publishing Co., 2165 E. Francisco Blvd., Suite A1, San Rafael, CA 94912; (415) 485-0948), while *PC-Kwik Power Disk* ($79.95) is an all-around speed-up-your-disk utility that includes a defragmenter (Multisoft Corp., 15100 SW Koll Pkwy., Beaverton, OR 97006; (800) 274-KWIK, (503) 644-5644). We reviewed *PC-Kwik Power Disk* in First Looks in our May 15, 1990, issue.

In addition, some general-purpose disk utilities that contain defragmenters appear in "Disaster Relief: DOS Utilities Save the Day," in our March 27, 1990, issue.

Memory architecture and speed, as well as BIOS shadowing, can speed things up, but the difference between, for example, 100-nanosecond RAM and 80-ns. RAM isn't nearly as noticeable as the difference that a faster processor and hard disk make. For a given amount of money, you're probably better off sticking with slower RAM and using the resulting savings to buy some extra for use as EMS memory or as a RAMdisk (provided your graphics package supports them).

Since you already have a VGA display subsystem, you really needn't buy a new one (unless you're unhappy with it for other reasons, of course) until you've tried it with your new system. If you still feel you want more speed, then try a faster VGA card. (See "16-bit VGA Cards Stretch the Standard," in our July, 1989, issue, for reviews of some fast 800 by 600 VGA cards.)

ASK THE ADVISOR

Send your questions to Advisor, *PC Magazine*, One Park Avenue, New York, NY 10016, or upload them to PC MagNet (see the "By Modem" sidebar in the Utilities column for access information). Please specify your equipment. ■

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ZEOS 386-20 PC MAGAZINE EDITOR'S CHOICE 5-30-89

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PC Magazine, May 30, 1989

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PC Magazine, May 30, 1989

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CIRCLE 276 ON READER SERVICE CARD

First Looks

Hands-on Reviews of the Latest Products

New IBM PS/2s Emphasize SCSI Mass Storage

HANDS ON

The machines are the message, and the new PS/2s from IBM state their claim loud and clear: PCs and particularly network servers don't need microprocessors quick enough to charge the air with brimstone to get the job done. IBM believes that faster storage is the point, and that's the story hidden inside the latest versions of the IBM Model 80 and the new Model 65SX.

From any other perspective, the new hardware from IBM should be considered an apology rather than an announcement. The top of the IBM line is now claimed by the 386DX-based Model 80-A31 ($13,195 with a 320MB hard disk, $10,695 as the 120MB Model 80-A21), a unit based on last year's 25-MHz technology. The new $5,995 Model 65SX-121 is based on a 16-MHz 386SX and comes with a 120MB hard disk; as the Model 65SX-061, it costs $5,295 with a 60MB hard disk.

Also announced were two 20-MHz versions of the Model 80, each has the same drives as the 25-MHz machines (the 320MB Model 80-131 lists for $9,895; the 120MB Model 80-121 for $7,495) and a better high-resolution monitor, the 14-inch Color Display 8515.

As system units go, the new machines offer little to rave about. The new Models 80 and 65SX put electronics similar to those of the Models 70 and 55 into the 23.5- by 6- by 19-inch plastic deskside case that's always been the foundation of the Model 80. As for performance, the pair registers within a few percent of their processor-matched predecessors on the PC Labs benchmark tests.

IBM's PS/2 model 65SX has parallel, serial, and mouse ports on the motherboard, along with floppy and VGA controllers.

The new 25-MHz versions of the Model 80 use genuine Intel 386DX chips matched to memory using Intel's 82385 cache controller and 64K of 33-nanosecond static cache. Two sockets accommodate up to 8MB of RAM on the system board on proprietary daughter-

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Low-Cost IBM LaserPrinter E Beats HP LaserJet IIP on Performance and Features

If the entries in your list of laser prospects all begin with the letters HP, it's time to expand your list. IBM's newly announced $1,495 LaserPrinter E, rated for a top speed of 5 pages per minute, surpasses the identically priced HP LaserJet IIP in nearly every respect, including speed, paper capacity, and emulations. Best of all, add IBM's new $499 PostScript Option and the required 1MB of upgrade RAM ($449) and you've got the least-expensive PostScript language printer going, at a total list price of $2,443.

IBM seems to have managed this bargain with efficient production and creative redesign. From its IBM laser engine to its 10-MHz Motorola 68000 processor, the LaserPrinter E matches IBM's 10-ppm, $2,395 LaserPrinter part for part, chip for chip. Almost.

While IBM reports that the two printers use different controllers—IBM is offering replacement 10-ppm controller boards for the LaserPrinter E for $1,099—the controllers in our evaluation unit differed only by virtue of four socketed firmware chips and one surface-mounted chip. PC Labs' testing of numerous evaluation units indicated that the LaserPrinter E firmware in effect inserts wait states to slow print speed.

While this artificial product differentiation seems almost comically absurd—IBM has gone to some expense and trouble to slow the LaserPrinter in firmware so that it can market it at a lower price—it also makes for a few unexpected boons.

For starters, the apparent wait states affect only text speed. In IBM Proprinter and HP LaserJet Series II emulation modes, our evaluation unit printed text at 4.8 ppm, a good bit slower than the LaserPrinter's 9.0 ppm. The two printers handled graphics at precisely the same speed, about 1.9 graphics ppm in Series II mode.

Results were more curious with the PostScript upgrade board, which works with either printer. With 2MB of upgrade RAM, the two printers perform identically in our tests in Post-

CONTINUES ON PAGE 36

IBM

CONTINUED FROM PAGE 33

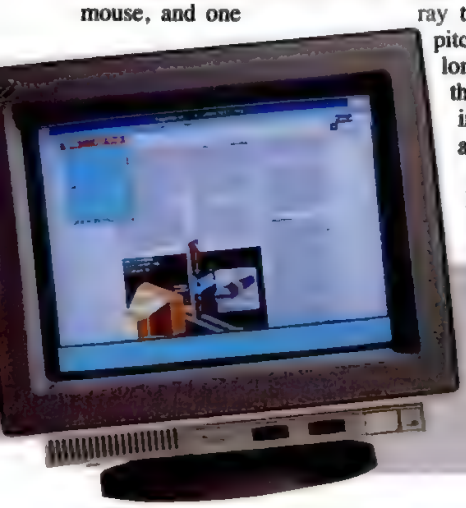
cards (standard equipment includes 4MB). Additional memory—up to an extra 8MB—must reside in one of the system's eight Micro Channel slots—four of which are full 32-bit, the balance 16-bit (two with VGA extension). Unlike the Model 70-A21, the Model 80 does not use IBM's Power Platform to permit relatively easy upgrades to 486 performance.

The Model 65SX, built around Intel's 16-MHz 386SX chip, has two SIMM sockets that accommodate up to 4MB of RAM on the system board (2MB are standard). Another 12MB of memory can reside in the Model 65SX's eight 16-bit Micro Channel slots. Oddly, none of these slots is equipped with the Matched Memory extension connector that allows the bus to speed up to the 16-MHz rate of the microprocessor for accessing memory.

The Model 65SX is home for another oddity: IBM has gone mainstream and used Dallas modules for its clock and SRAM configuration memory, and has eliminated the lithium battery and its wiring from the speaker assembly. The Model 65SX is now assured a trip to the repair shop in 10 years to replace the exhausted battery-based Dallas modules.

Both the Models 80 and 65SX machines include 250-watt power supplies as well as one parallel, one serial, one mouse, and one keyboard port built into the system board. Floppy disk control is also part of the system board, as is VGA. The latter continues to use IBM's laggardly 8-bit interfaced design.

IBM's preferred video system is the optional plug-in 8514/A graphics adapter, which delivers interlaced 1,024- by 768-pixel resolution. The new $950 Color Display 8515 monitor is designed to plug into that adapter and yields a 14-inch image on a shadow-mask cathode-ray tube with a 0.31mm dot-pitch. It is equipped with a longer persistence phosphor than the 8514 display, yielding little flicker and no image lag. Instead of brightness and contrast, the 8515 has two brightness controls—one for normal in-

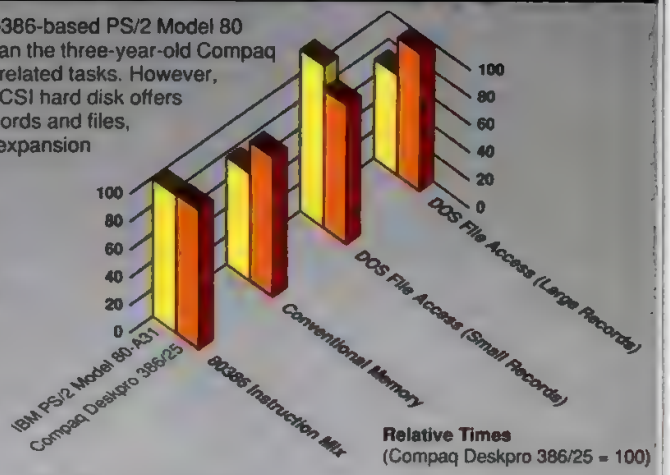


IBM's 8515 color monitor ($950) displays a 14-inch image with 0.31mm dot pitch.

BENCHMARK TESTS: IBM PS/2 MODEL 80-A31

PC LABS

IBM's new 25-MHz, 80386-based PS/2 Model 80 performs little better than the three-year-old Compaq Deskpro 386/25 in processor-related tasks. However, the IBM file server's 320MB SCSI hard disk offers better I/O results on larger records and files, and the 32-bit Micro Channel expansion bus will also benefit network performance.



The **80386 Instruction Mix** benchmark test times a series of tasks specific to the 80386 chip. Since this test shows how the CPU operates in the context of the bus, processor, system memory, and motherboard architecture, a faster time means better overall computer performance.

The **Conventional Memory** benchmark test measures the read/write speed of the first 640K of memory. Slower relative times can indicate the presence of memory wait states or memory chips rated at slower access speeds.

The **DOS File Access (Small Records)** benchmark test times disk throughput as a result of mechanical disk drive speed, hard disk controller function, and bus speed. The test is performed without software disk caching. Fast times are advantageous for programs that work with many short segments of data.

The **DOS File Access (Large Records)** benchmark test times disk throughput as a result of mechanical disk drive speed, hard disk controller function, and bus speed. This test minimizes the effect of small hardware caches on disk subsystem performance. It is performed without software disk caching. Fast times are advantageous when large files are loaded.

Performance Times (Times given in seconds)	80386 Instruction Mix	Conventional Memory	DOS File Access (Small Records)	DOS File Access (Large Records)
IBM PS/2 Model 80-A31	2.28	0.36	66.62	4.69
Compaq Deskpro 386/25	2.31	0.47	56.83	6.5

THE IMPORTANCE OF BEING SCSI

by Winn Rosch

The challenge of the Small Computer System Interface (SCSI) lies in coupling it with PCs, and IBM's latest attempt brings both promise and disappointment. SCSI disks can deliver better performance than those with any other commonly available interface, but little of that speed shows up when running DOS.

SCSI differs from the other disk interfaces—ST506 and ESDI—by being a higher-level interface, using parallel connections, and being controlled by its own command language, not just hardware signals.

Both the ST506 and ESDI interfaces are serial. All data is sent on a single connection. For standard MFM hard disks, this is a logical choice, because the raw data can be read as a single continuous stream from the disk and passed through the interface to the controller. It's also potentially slow, because all the data has to be squeezed through a single line.

SCSI, as originally conceived, uses an 8-bit parallel connection, although a newer standard not used by IBM, SCSI-2, can handle both 16- and 32-bit link-ups.

In SCSI systems, the data separator and other disk controller functions are integrated on the drive to develop the parallel bus information. Because of this, the data-coding scheme used to store information on-disk (such as MFM or RLL) and even the disk format itself are invisible to your computer and its SCSI adapter.

That's why SCSI does not test well with DOS-based benchmark tests. While DOS is geared to deal with disk clusters, SCSI works with data blocks. Programs that take direct control of disk hardware—including benchmark

tensity, the other for high-intensity colors.

The real message to be derived from the new hardware is that IBM can build disk drives. Although that's not news for mainframe users (IBM's mainframe disk drives have an enviable reputation), the company's previous PC products have been welcomed as warmly as blemishes on prom night. No more. The 320MB IBM disk ($5,500 if purchased separately) is rated as the fastest 3.5-inch drive available with a 12.5 millisecond average access time—a claim you'll have to take on faith, because standard benchmark tests stall when faced with the new drive's SCSI (Small Computer System Interface) technology (see sidebar).

IBM also offers 120MB ($1,920) and 60MB ($1,200) SCSI drives. Both 3.5-inch disk drives promise a 23-millisecond average access time that's accelerated by 32K of on-the-drive hardware cache.

Better access time is the data-transfer rate claimed by the new drives. To match the drives to Micro Channel system units, IBM also introduced two bus-mastering SCSI adapters—one with a 16-bit interface (which is standard equipment in all the new PS/2s) and another with a 32-bit interface. These are rated to deliver fast data-transfer rates from board to bus, 8.6MB/second for the 16-bit adapter and 16.7MB/second with the wider connection. While the SCSI connection itself is limited to 5MB/second, that still outclasses the fastest ESDI systems, which don't even rate 2MB/second.

As with the drive array in Compaq's Systempro, IBM's SCSI system finds and moves data fast, but without an advanced operating system that performance is invisible to DOS and DOS-based benchmark tests. Unlike the Compaq disk array, however, IBM's SCSI system is based on an open-architecture industry standard.

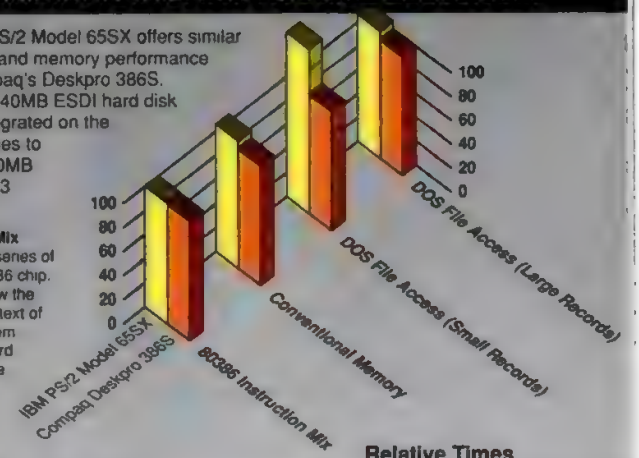
If your network demands a lot of storage, you can plug up to four hard disks into the hard disk cage inside IBM's new PS/2s, for a total of 1.28 gigabytes; older IBM towers accommodate two internal disks. More drives can be added externally (although IBM does not yet supply hardware to do so), for a total of seven devices per SCSI controller and up to four controllers per tower.

Even with the new hard disks, however, the new PS/2s are not the machines that dreams are made of. Not designed to be glamorous, they are adequate computers—as sturdy, potentially reliable, and forgettable as bricks.

Besides the message, these machines also pose a question: If IBM can build a price-performance leading workstation (the RS/6000) and the fastest PC hard disks, why not system units that power users would covet? Neither the latest versions of the Model 80 nor the 65SX hint at an answer. ■

BENCHMARK TESTS: IBM PS/2 MODEL 65SX-031

The IBM PS/2 Model 65SX offers similar processor and memory performance compared with Compaq's Deskpro 386S. However, Compaq's 40MB ESDI hard disk with its controller integrated on the system board manages to outperform IBM's 120MB SCSI drive rated at 23 milliseconds.



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The **DOS File Access (Small Records)** benchmark test times disk throughput as a result of mechanical disk drive speed, hard disk controller function, and bus speed. The test is performed without software disk caching. Fast times are advantageous for programs that work with many short segments of data.

Relative Times
(Compaq Deskpro 386s = 100)

The **DOS File Access (Large Records)** benchmark test times disk throughput as a result of mechanical disk drive speed, hard disk controller function, and bus speed. This test minimizes the effect of small hardware caches on disk subsystem performance. It is performed without software disk caching. Fast times are advantageous when large files are loaded.

Performance Times (Times given in seconds)	80386 Instruction Mix	Conventional Memory	DOS File Access (Small Records)	DOS File Access (Large Records)
IBM PS/2 Model 65SX	4.49	0.88	88.01	7.77
Compaq Deskpro 386S	4.48	0.83	64.04	7.31

tests that measure average access times—must be processed by the SCSI controller and turned into block commands.

SCSI fits with the Micro Channel philosophy in several ways. Its parallel nature offers speed.

It also has a further advantage in advanced PCs allowing several devices connected to a single SCSI adapter to communicate without the need for the host computer to intervene. For example, a hard disk could be backed up to a SCSI tape drive while the rest of the computer system is otherwise engaged.

This facility dovetails well with the Micro Channel's bus-mastering abilities. A bus-mastering SCSI adapter can transfer information to system memory without stealing processing time from the microprocessor. In other words, SCSI will help designers add intelligent subsystems to computers, and that's the point of the Micro Channel, too. ■

FACT FILE

IBM PS/2 Models 80
IBM PS/2 Model 65SX
IBM Color Display 8515

IBM Corp., (contact your local IBM dealer).
List Price: Model 80-121 (20 MHz), with 4MB RAM, 120MB SCSI hard disk, 1.44MB floppy disk drive, serial, parallel, mouse ports, VGA, $7,495; Model 80-312 (20 MHz), as above with 320MB SCSI hard disk, $9,895; Model 80-A21 (25 MHz), as above with 120MB SCSI hard disk, $10,695; Model 80-A31, as above with 320MB SCSI hard disk, $13,195. Model 65SX-061, with 2MB RAM, 60MB SCSI hard disk, 1.44MB floppy disk drive, serial, parallel, mouse ports, VGA, $5,295; Model 65SX-121, as above with 120MB SCSI hard disk, $5,995. Color Display 8515, $950.
Requires: VGA or 8514/A adapter for Color Display 8515.
In Short: The new 20-MHz and 25-MHz versions of the Model 80 are slow but sturdy tower-style Micro Channel PCs with eight expansion slots (four 32-bit), 16-bit bus-mastering SCSI adapter, four internal 3.5-inch hard disk bays, built-in 8-bit VGA graphics. The 16-MHz 386SX-based PS/2 Model 65SX is a tower-style computer with eight 16-bit Micro Channel expansion slots, bus-mastering SCSI adapter, four internal 3.5-inch hard disk bays, and built-in VGA graphics. The 8515 14-inch color monitor offers analog inputs capable of displaying VGA images and interlaced 1,024- by 768-pixel images generated by IBM's 8514/A graphics adapter. Features a dark screen to increase contrast and long-persistence phosphor to minimize interlace flicker.

CIRCLE 449 ON READER SERVICE CARD

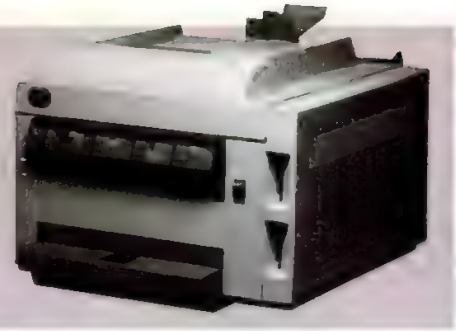
Printer

CONTINUED FROM PAGE 33

Script emulation mode, whether printing text or graphics. PostScript text speed was 5.6 pages, while graphics speed was 0.6 graphics pages per minute. (IBM reports that the LaserPrinter will print PostScript text at close to 10-ppm when equipped with 3.5MB of upgrade memory.) When using other emulations with the PostScript board installed, the LaserPrinter E increased its text speed by 1 ppm, to 5.8.

Once past their differences in speed, the LaserPrinter and LaserPrinter E offer the same generous array of features and options. In addition to its IBM Proprinter and HP LaserJet Series II emulations, the LaserPrinter E emulates the IBM Graphics Language and HP Graphics Language. In other words, it emulates IBM and HP plotters. The machine will accept HP-compatible downloadable fonts, but the two font slots at the right front of the cabinet accept only proprietary cards, which range in price from $142 to $245.

The LaserPrinter E earns especially high scores for paper-handling capabilities and options, especially when compared with the paper-handling capabilities of the LaserJet IIP. The LaserPrinter E's standard paper cassette holds 200 sheets and adjusts for different sheet sizes, up to 8.5 by 11 inches. The manual-feed tray, awkwardly located at the rear of the machine, accommodates heavy stock, up to 35 pounds, through a straight-through path into the face-up tray.



IBM's LaserPrinter E outperforms the HP IIP. For an added $499, it's the cheapest printer around.

IBM's office-strength paper-handling options include a luxurious, 500-page cassette. The cassette attaches to the bottom of the machine and comes with an adjustable, letter-size tray. The $329 envelope feeder attaches to the manual feed slot and accommodates up to 75 envelopes.

IBM designed the LaserPrinter and LaserPrinter E so that the right-side panel pivots down to expose the controller, no tools required. While every explorer will relish the easy access, it undoubtedly springs from pragmatic concerns: both the memory and PostScript upgrades install directly onto the controller. The LaserPrinter E comes standard with 512K RAM and can accommodate up to 3.5MB of additional memory, which comes in the form of small daughtercards. The cards list at $449, $899, and $1,599 for 1MB, 2MB, and 3.5MB versions, respectively.

IBM's PostScript language upgrade comes in two versions, both of which offer genuine Adobe PostScript, Version 52.1. The $499 PostScript Option comes with the upgrade board and its 17 resident typefaces: Courier, Helvetica, Helvetica Narrow, Times, Symbol, and variations on these. The $899 Premium PostScript Option adds a card with 22 additional typefaces, which include ITC Bookman, ITC Avant Garde Gothic, New Century Schoolbook, and Palatino, among others.

The LaserPrinter E uses the same $199 all-in-one toner/drum cartridge as the LaserPrinter. Though it costs about twice as much as the IIP's $95 cartridges, the IBM cartridge also lasts approximately three times as long, with a rated life of 10,000 pages. The cartridges slide easily in and out of place.

In its default configuration, the LaserPrinter E accepts only a parallel connector. A $489 option provides six serial ports for printer sharing.

Our only real complaint with the performance of this machine lies with print quality. When using HP emulation, the LaserPrinter E produces a shinier surface over solid black areas than most lasers, though it rivals the best of the competition in every other regard. While this may sound like nit-picking, the shine does detract from the overall appearance of graphics.

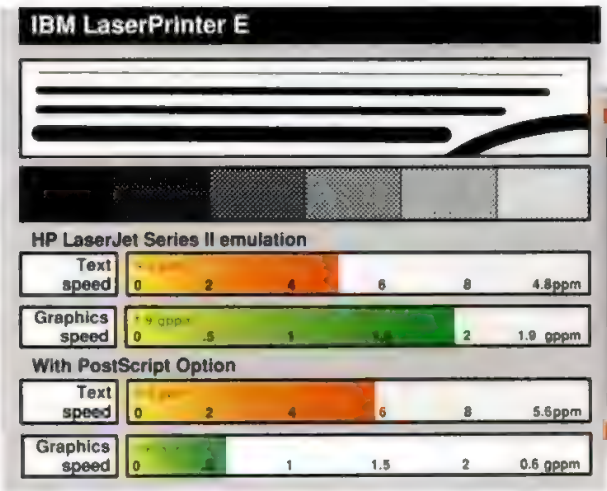
All in all, however, the LaserPrinter E unquestionably rates among the best buys going in laser printers today. With or without the PostScript upgrade, it performs significantly faster than the LaserJet IIP. The IIP also falls behind in any feature-by-feature comparison.

For people in the market for a low-cost PostScript printer or a low-cost printer they can upgrade inexpensively later, the LaserPrinter E should be the obvious choice. ■

FACT FILE

IBM LaserPrinter E
IBM Corp. (contact your local authorized IBM dealer); (800) IBM-2468, ext. 130.
List Price: LaserPrinter E, $1,495; PostScript Option, $499; Premium PostScript Option, $899; 1MB RAM upgrade, $449; 2MB RAM upgrade, $899; 3.5MB RAM upgrade, $1,599; controller upgrade to LaserPrinter, $1,099 (dealer installed only); envelope feeder, $329; legal-sized tray for standard cassette, $69; 500-sheet paper cassette, $399; legal-size tray for 500-sheet cassette, $99; downloadable font packages, $199; font cards, $142 to $245; six-port serial printer-sharing module, $489; replacement print cartridges, $199.
Dimensions (HWD): 11.25 by 14.2 by 20.5 inches.
Weight: 33 lbs.
In Short: Essentially a 5-ppm version of IBM's $2,395 LaserPrinter, the LaserPrinter E offers the same wealth of features and options at a bargain price. A $499 PostScript upgrade board makes the printer an especially good buy for would-be PostScript users.

CIRCLE 448 ON READER SERVICE CARD



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TECHNICAL REQUIREMENTS: IBM PC, AT, XT, PS/2 or compatible with a minimum of 512Kb RAM, a hard disk, MS-DOS 3.0 or later, a LaserJet Plus, Series II, IID, IIP or compatible printer with standard memory

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CIRCLE 299 ON READER SERVICE CARD

Norton Backup Offers Speed, Macros, Automation

HANDS ON
by Edward Mendelson

Any backup program can preserve and restore your files, as long as you're willing to endure the tedium of feeding myriad floppy disks into a drive. The best backup programs can't make the job less tedious, but they can make it faster, easier, and more reliable. *The Norton Backup*, Peter Norton Computing's $149 backup package, does all that and more for beginners, advanced users, and—in ways unmatched by other backup programs—for corporate users as well.

Norton Computing's program surpasses the speed of its fastest rival, *FastBack Plus*, and the conveniences of slower programs. In our informal tests, using the fastest options in both packages, *Norton* took 6 minutes 24 seconds to back up a set of files that took *FastBack Plus* 7 minutes 36 seconds. *Norton*'s *Microsoft Windows*-like menus make it simple to navigate through the program's exceptionally broad range of options. Those options include a setting that explicitly lets you copy files to floppy disks without letting the program think the files have been backed up—something you can do in other programs only if you're intimate with the meaning of the DOS archive bit. *The Norton Backup* also includes a hypertext help system that explains every detail of the program more clearly than the rather skimpy manual that comes with the program.

One of the options buried deep in *Norton*'s menus is a choice between backup diskettes formatted to be readable by DOS or diskettes that use a proprietary format. *Norton* achieves its highest speed only when you override the default setting and choose the proprietary format.

The Norton Backup avoids the usual inconvenience of non-DOS-readable backup formats, which is the "Retry, Abort, Fail" message you get when you ask DOS for a directory of the diskette. *Norton*'s disks display an explanatory warning message when DOS tries to read them, which means that you don't need to run the backup program to find out whether the disk is a backup disk or merely a blank. When *Norton* creates DOS-readable disks, as *FastBack Plus* always does, its speed is virtually identical to *FastBack*'s but it consumes more disk space—in our tests, sometimes enough to require an additional disk.

Like its better rivals, *The Norton Backup* lets you automate its operations with setup files and keyboard macros, and you can run complex automated backup sessions from a batch file. Also like its rivals, *Norton* offers different menu levels for different users. The basic level lets you select drives, directories, or files from a directory display and simply back them up or restore them. Advanced users can save time by typing in file specifications if they don't want to point to them on a menu, and can choose from a wide range of options, including different levels of verification, compression, overwrite warnings, and formatting. All these options can be saved in setup files, which, unlike those in most rival programs, support multiple drives in individual setups.

Norton makes the best possible use of these setup files for corporate situations where backups must be tailored to nontechnical users. You can configure *The Norton Backup* to a "Preset" level in which the only choices available to the user are among setup files, each displayed on the opening menu with an intelligible descriptive name. One option accessible in the preset or advanced level automatically performs a full backup whenever the program is run after a specified interval, even if the program is set up to perform only interim backups. As in other programs, these interim backups can save files created or modified since the last interim backup, or files created or modified since the last full backup.

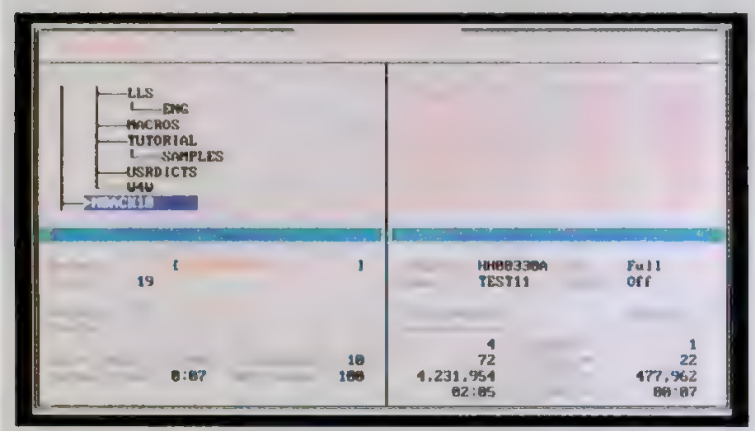
Version 1.0 of *The Norton Backup* is scheduled to be replaced by Version 1.1 almost certainly before you read this, and the upgrade will be free on request. The upgrade, which we tested as a preproduction copy, adds the ability to restore a file automatically by specifying its name on the DOS command line, so you don't have to wade through menus to get back yesterday's version of the file you demolished today. The upgrade also dramatically increases the speed of the original. The proprietary-format backup that took 6 minutes 24 seconds with Version 1.0 takes only 4 minutes 40 seconds with Version 1.1. A DOS-format backup, amazingly, was only 40 seconds slower.

Versions 1.0 and 1.1 support only floppy disk drives, but support for standard QIC-40 and QIC-80 tape drives is due by the middle of the year, with more extensive tape support due by autumn. Even without those features, *The Norton Backup* is already the program that coddles you and your data better than any other. ■

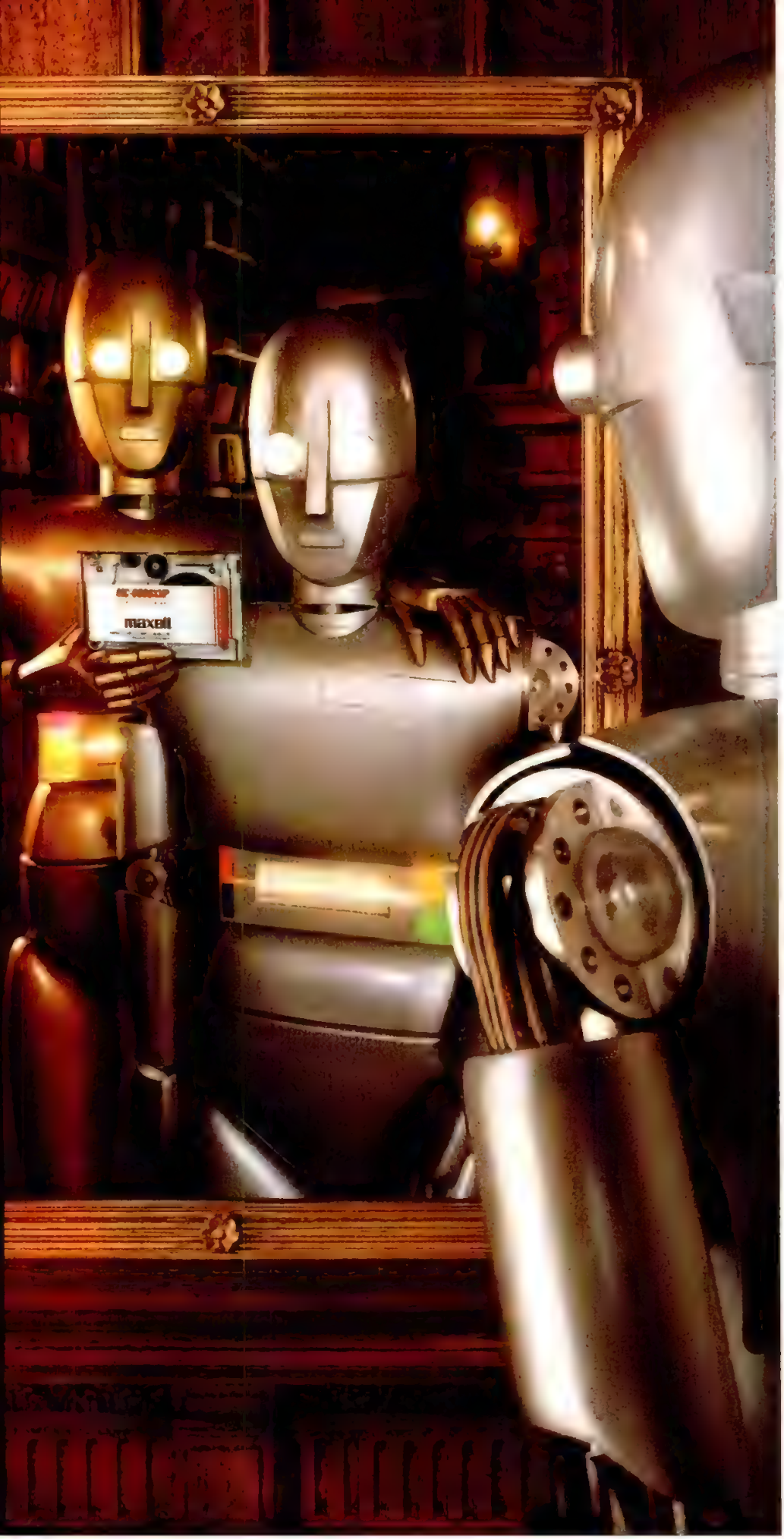
FACT FILE

The Norton Backup
Peter Norton Computing Inc., 100 Wilshire Blvd., Santa Monica, CA 90401; (800) 365-1010, (213) 319-2000.
List Price: $149.
Requires: 384K RAM, hard disk, DOS 3.0 or later.
In Short: Convenient menus, high speed, and command-line restores make this the best available backup program.

CIRCLE 439 ON READER SERVICE CARD



***The Norton Backup* displays the progress of a backup session in detail. Filenames change color after being backed up.**



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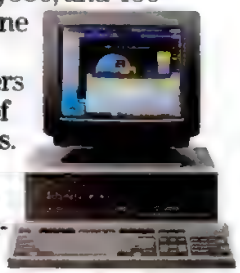

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CIRCLE 372 ON READER SERVICE CARD

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CIRCLE 260 ON READER SERVICE CARD

Magellan 2.0 Offers New Types of Viewers, File Compression, and Improved Built-in Macro Language

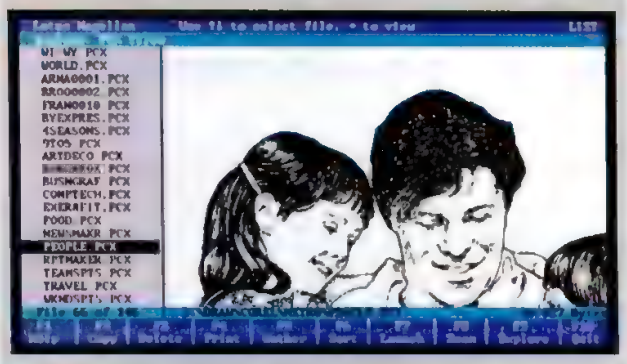
HANDS ON

It's a tough act to follow when Version 1.0 of a product wins a technical excellence award from *PC Magazine*. But Version 2.0 of Lotus Development Corp.'s *Magellan*—a file and data organizer that excels at searching for files containing a given word or group of words—is a significant upgrade. The $139 program ($39 for Version 1.0 users) offers several important enhancements, including almost transparent compression of data files, an improved macro language, and wonderful new viewers.

The basic look of *Magellan* has not changed. Once you've initiated a search, *Magellan* will display a column on the left side of the screen that lists all matching files. On the right-hand side you'll see the contents of the first matching file in native format, so that a spreadsheet looks like a spreadsheet rather than a binary file.

This idea of viewing data in native format has taken the DOS shell industry by storm. After *Magellan* 1.0 shipped with 16 read-only viewers, *Norton Commander*, *XTreePro*, and *PC Tools* rushed to catch up and surpass it with file viewers of their own. Lotus has answered them all by packing 40 viewers into *Magellan* 2.0. While Version 1.0 could only read Lotus' own .WKS, .WK1, and .WK3 formats, the new *Magellan* also reads *Microsoft Excel*, *Multiplan*, and *Quattro Pro* native formats. And while *Norton Commander* 3.0 and *PC Tools* 6.0 each have added a viewer for reading *PC Paintbrush*'s .PCX graphical format, *Magellan* 2.0 counters with one of its own plus viewers for CompuServe .GIF, *Lotus* .PIC, and *Lotus Freelance Plus* .DRW files. In an informal test using the .PCX files on my hard disk, *Magellan*'s .PCX viewer could read 145 out of 148 files, *PC Tools* could read 123, and *Norton Commander* only 69.

Even more significant are the useful ways *Magellan* 2.0 extends the functionality of viewers. First, you can now use an editor viewer and an undelete viewer to change files. Second, you can use a viewer to look at data produced by other programs in a unique way. For example, *Magellan* offers a viewer for CompuServe messages that formats them to present To, From, and Subject information in one line per message. Simply highlight the message you want to view, hit Enter, and the full message will be displayed. If you're a *Lotus Express* user, an *Express* viewer will let you view attached files.



Among *Magellan* 2.0's 40 file viewers is one for reading *PC Paintbrush*'s .PCX graphics format. Other new viewers let you read .GIF, .PIC, and .DRW file formats.

Most striking is a new class of viewers that can call other viewers. For example, you use *Magellan*'s Gather command to collect a bunch of file specs into a new file. When you view that file with the program's new datalink viewer, and then hit Enter to select a filename, you can view the contents of that file. You can add notes to the file that contains the specs to remind yourself what information the other files contain.

Just as exciting is a new viewer that handles files compressed with Phil Katz' *PKZIP* program, which typically shrinks binary files by 30 to 50 percent, text files by 50 to 70 percent, and some database files by a factor of ten. Lotus has licensed Katz's code, and has built into *Magellan* the ability to zip and unzip files as well as view zipped files directly.

When *Magellan* tries to view a zipped file, it will automatically unzip it and then display it in native format. You can even delete a zipped file that contains a .PCX file and then use the undelete viewer to look at that original .PCX file.

Magellan 1.0's most spectacular feature was its ability to make a small index and then search your hard disk quickly for all files that contain a given word. Version 2.0 can do that, of course. But its indexes can now include information on zipped files. You can also search a group of files and tell *Magellan* to continue an unsuccessful search into successive files until it finds a match.

Lotus has also strengthened *Magellan*'s built-in macro language. You now have at your disposal pop-up menus and dialog boxes, as well as the ability to command a macro to explore paths and to totally rearrange your function key setup. *Magellan*'s backup/restore module doesn't use any compression techniques, but it makes choosing files a breeze. You can also include a file signature on some of your files as a way of checking for subsequent corruption. And, rather than forcing you to type the full pathname of a destination for a file that is to be copied or moved, the new version of *Magellan* lets you choose the destination from a visual tree.

Magellan does have a few weak points. Its tree diagram only shows at most one directory and its list of subdirectories at a time and isn't as intuitive or useful as those you'd find in most DOS shells. The program is crying out for the mouse support you'll find in *Norton Commander* and *PC Tools*. More graphics viewers, especially those for .TIF and .CGM files, wouldn't hurt, either.

But if you care about quick access to and organization of your data, you simply *must* have a copy of *Magellan* 2.0. ■

FACT FILE

***Magellan* 2.0**
Lotus Development Corp., 55 Cambridge Pkwy., Cambridge, MA 02142; (617) 577-8500, (800) TRADEUP for upgrades.
List Price: $139; upgrade from 1.0 is $39; upgrade from any version of *The Norton Utilities*, *Norton Commander*, *PC Tools*, *Mace Utilities*, *Fastback Plus*, and *XTree*, $49.
Requires: 256K RAM, hard disk with at least 1MB free, DOS 2.0 or later.
In Short: For tracking, organizing, and finding your data on your hard disk, there is nothing like *Magellan*. Version 2.0 adds file compression, new viewers, and better macros to its bag of disk-searching tricks.

CIRCLE 447 ON READER SERVICE CARD

Panasonic Business Partner CF-150B: No-Frills Laptop Features Bright Screen

HANDS ON
by Matthew J. Rose

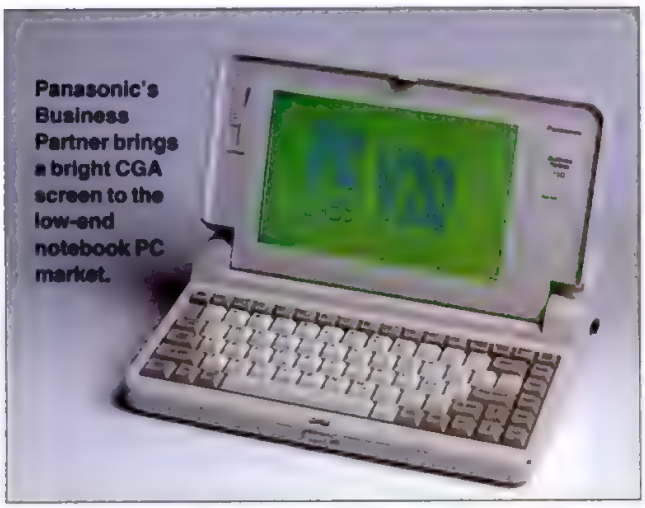
You're probably more familiar with Panasonic clock radios and televisions than the company's personal computers. After successfully penetrating the dot matrix printer market, Panasonic has now set its sights on PCs, and the $1,149 CF-150B Business Partner is the first small step.

A quick glance at the Business Partner might lead you to mistake it for the Tandy 1100 FD, and with good reason: Tandy manufactures the unit for Panasonic, but two major differences distinguish the Business Partner from its counterpart. The Business Partner features a large backlit display that sets it apart from most of the low-end floppy-only laptops, including Toshiba's T1000 and the 1100 FD. The other difference is that Tandy includes its *DeskMate* integrated software in ROM, while Panasonic only has DOS 3.3.

The backlit LCD is one of the Business Partner's major selling points. The display's actual viewing area measures a roomy 7.5 by 4.6 inches with CGA graphics at 640- by 200-pixel resolution. Panasonic's screen features blue characters against a light green background. The unit's unusual color scheme proves to be quite legible and easy on the eyes.

With dimensions of 2.5 by 12 by 9.75 inches, the Business Partner isn't the smallest laptop you can buy, but it nevertheless fits easily into your briefcase. Nor is Panasonic the lightest, weighing 7 pounds with a battery, a weight comparable with the Compaq LTE with its hard disk. An AC transformer adds another half pound.

Like the Tandy 1100 FD, Panasonic's Business Partner features a rechargeable 6V, 1.8 AH lead acid battery. While the manufacturer claims a 4-hour battery life, results on PC Labs Battery Rundown performance test were disappointing. With the backlighting on, the battery lasted only 1 hour and 24 minutes, and needed 10 hours to recharge fully. Since the unit shares the same power supply as its nonbacklit and less power-consuming cousin, the poor performance is not surprising. A more powerful battery would help significantly.



Panasonic's Business Partner brings a bright CGA screen to the low-end notebook PC market.

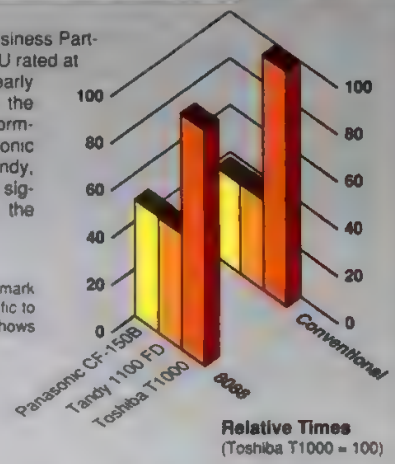
Even though the keyboard has clearly visible decals on the keycaps, which might wear off, the Business Partner CF-150B's 84-key keyboard is a plus overall. It is larger than most notebook-size portables' keyboards, and with 12 function keys and an intelligent layout, it is comfortable to use.

The Panasonic Business Partner's expansion possibilities are severely limited. The standard unit ships with 640K of RAM, and DOS 3.3 stored in ROM. A 1MB upgrade is available and can be configured as extended memory or a RAM disk. An optional modem card resides in a dedicated slot at the rear of the unit, alongside the system's only 2 ports: a 9-pin serial port and a parallel port. The Panasonic Business Partner CF-150B's one 3.5-inch disk drive accepts 720K floppy disks, and there is no external monitor support.

Panasonic can't match the Toshiba T1000's street price ($550) or the Tandy 1100 FD's ROM-based software, and the Business Partner's battery needs a booster shot to drive the power-hungry LCD. But if you're looking for a no-frills laptop with a readable screen and a comfortable keyboard, Panasonic's Business Partner will run anything you can fit on a double-density disk, 640K, and CGA. ■

BENCHMARKS TESTS: PANASONIC CF-150B BUSINESS PARTNER

The Panasonic CF-150B Business Partner features a NEC V20 CPU rated at 8 MHz with performance nearly identical to its counterpart, the Tandy 1100 FD. Battery performance is disappointing: Panasonic uses the same battery as Tandy, but its backlit display draws significantly more power than the nonbacklit 1100 FD.



The **8088 Instruction Mix** benchmark test times a series of tasks specific to the 8088 chip. Since this test shows how the CPU operates in the context of the bus processor, system memory, and motherboard architecture, a faster time means better overall computer performance.

The **Conventional Memory** benchmark test measures the read/write speed of the first 640K of memory. Slower relative times can indicate the presence of memory wait states or memory chips rated at slower access speeds.

The **Battery Rundown** performance test involves teletyping five screens of text to the laptop computer's display, then writing a 15K file to the hard disk once every minute until the battery runs out of power. All power conservation techniques are disabled.

Performance Times (Times given in seconds)	8088 Instruction Mix	Conventional Memory	Battery Rundown Elapsed Time (hours and minutes)
Panasonic CF-150B	16.15	2.41	1:24
Tandy 1100 FD	16.09	2.44	3:19
Toshiba T1000	32.96	6.4	4:56

FACT FILE

Panasonic CF-150B Business Partner
Panasonic Communications and Systems Co., 2 Panasonic Way, Secaucus, NJ 07094; (201) 348-5357.
List Price: With 640K RAM, one 720K 3.5-inch floppy disk drive, backlit CGA liquid crystal display, DOS 3.3 in ROM, utilities, $1,149.
In Short: A basic floppy-only portable with a readable backlit LCD and a comfortable keyboard, the Business Partner suffers from an anemic battery and an unnecessary pound or two. But given the limited competition in the low-end notebook laptop market, the Panasonic CF-150B Business Partner is a viable choice if you want things kept simple.

CIRCLE 460 ON READER SERVICE CARD

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- **3X-Link16 for DOS** with file transfer at 500 000 Bps, printer sharing and E Mail.
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CIRCLE 234 ON READER SERVICE CARD

UltraStor ESDI Controllers: Disk Duplexing on the AT Bus

HANDS ON by Edward Mendelson

It always seemed that the more advanced your hard disk, the more intense the headache induced by its controller. And until the arrival of UltraStor Corp.'s $250 Ultra 12, ESDI controllers were the most headache-inducing of all.

The Ultra 12 comes with network features otherwise available only on the Compaq Systempro, but it's fast and flexible enough to make it the ESDI controller of choice for standalone systems. It supports up to two ESDI drives with transfer speeds of 10, 15, or 20 megabits per second; most of the competition hits the wall at 15.

Its unique ability to coexist with any other hard disk controller (including IDE) lets you transfer data from your old disk to a new ESDI disk without detouring through backup disks or tapes. Jumper settings let you install hard disks larger than 528MB as a single partition without third-party software. You can also install up to three floppy disk drives.

Like the EISA-bus controller in the Compaq Systempro, the Ultra 12 supports disk duplexing under Novell's *NetWare 386*. This means you can install two controllers and two hard disks (or two pairs of hard disks) in the same computer and write the same data simultaneously to both combinations of controller and disks. If one disk or controller fails, the other lets the network continue without interruption. No other standard-bus controller has this feature.

The Ultra 12(F) is a two-thirds-length, XT-height board that comes with 8K of cache RAM, upgradable to 32K. With 32K installed at the factory—the configuration we tested—the list price is $275. A full-fledged caching model, the Ultra 12(C), will also be available, with a list price of $695 for a 512K cache, upgradable to 3MB. An EISA model is also on the way.

The Ultra 12's installation program is easier to use than any other controller's and offers more options. Other controllers match the Ultra 12's options for fine-tuning your drive's head skew and cylinder skew, but the Ultra 12's manual is the only one that tells you how to calculate the best setting. (Head and cylinder skew allow sectors to be offset in order to reduce the time needed for the head to find the right sector.)

Using the default settings, with a 32K cache, I measured transfer rates up to 35 percent higher than with competing controllers from Scientific Micro Systems and Adaptec, one with no cache, one that ships with 8K or 16K. The only alternative toward better performance is with a full-fledged caching controller at twice the price or more. ■

List Price: Ultra 12(F), $250 (8K cache), $275 (32K cache). **Requires:** 16-bit slot in any standard-bus AT or 386 computer, including IBM PS/2 Model 30 286. UltraStor Corp., 15 Hammond, #310, Irvine, CA 92718; (714) 581-4100.

CIRCLE 434 ON READER SERVICE CARD

Frye Utilities for Networks Makes Novell LAN Management Much Easier

HANDS ON by Joseph Fitzsimons

If you're a network manager, Novell *NetWare*'s SYSCON utility will help you gain enough information over time to understand how an existing network has been set up. But if you've ever wished for utilities that will let you see at a glance what LAN cards have been installed in an unfamiliar server or how user accounts were created by your predecessor, look no further than the *Frye Utilities for Networks—NetWare Management*. The $495 package dramatically reduces the amount of time you'll need to maintain, troubleshoot, or reconstruct an existing Novell network.

The *Frye Utilities* comes in single and multiple server versions. The latter lets you switch among servers, adhering to *NetWare*'s privilege structure. You must have supervisory privileges or equivalent to access all of the information available through the *Frye Utilities*. If you just have console operator privileges, *Frye* will display information only for the directories that you have rights to.

The Frye Utilities for Networks displays a bar graph showing a history of network utilization for the past 30 seconds.

Frye's 13 modules and three standalone utilities provide data about your network, including server utilization, activity by station, which files are open, user and group information and rights, trustee assignments, log-in scripts, physical drives and volumes in a server, cache statistics, transaction tracking, and more. A Comprehensive Configuration Report, one of many reports the program offers, details all the important configuration options chosen during installation. Each category included in this report can also be run as a separate report. You can rerun the Comprehensive Configuration Report or a subset to document subsequent changes to the network. In addition, a Reports Module offers you two types of Weekly System Maintenance Reports, two System Exception Reports, and four Disk Utilization Summary Reports (volume, user, user sorted by usage, and directory).

You can send reports to your screen, printer, file, and can also run them from the DOS command line. *Frye* warns you that a large report will take several minutes to complete, giving you the option to continue or return to the menu screen.

The package goes beyond what Novell offers in several ways. Unlike Novell's own FCONSOLE, which only lets you view status and activity information about one user at a time, *Frye* offers you data on 16 users in one screen. *Frye*'s Server module displays a helpful bar graph showing a history of utilization for the past 30 seconds. *NetWare* only gives you one second of information at a time. Complementing that, *Frye* will display the amount of file reading and writing on the server.

Frye's manual is easy to follow, and includes lots of sample reports. Especially useful is its reference section—a glossary of *NetWare* and network terms.

In sum, all Novell network managers should keep a copy of the *Frye Utilities* by their side. It makes network administration much more bearable. ■

List Price: *The Frye Utilities for Networks—NetWare Management*, $495. **Requires:** Novell *NetWare* Version 2.1x, DOS 2.0 or later. Frye Computer Systems Inc., John Hancock Tower, 200 Clarendon St., Boston, MA 02116; (617) 247-2300.

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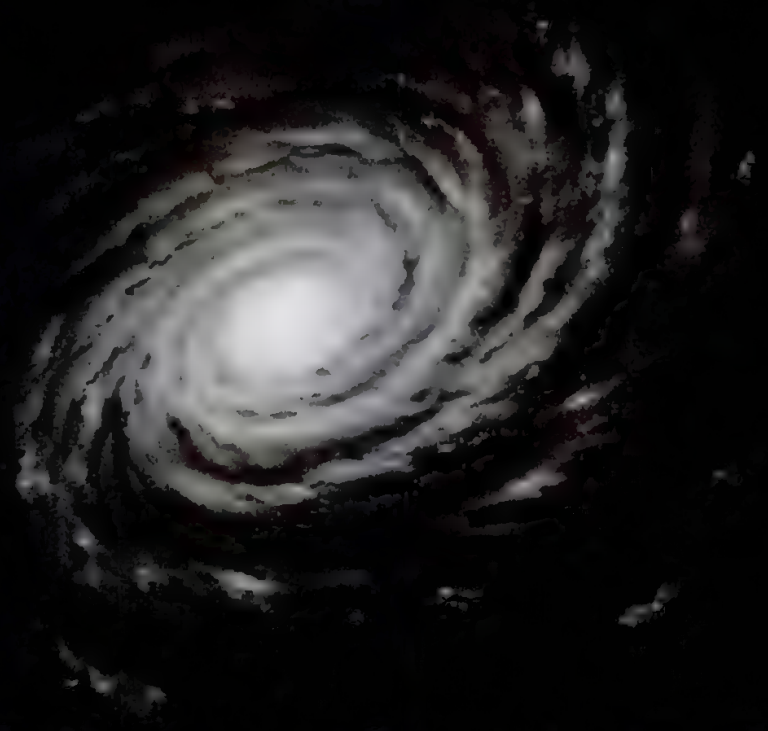

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CIRCLE 313 ON READER SERVICE CARD

Logic Gem Analyzes Complex Logical Problems, Expresses Them In English

HANDS ON
by Richard Hale Shaw

While electronic spreadsheets make it easy to perform what-if analyses with numbers, most of us spend as much if not more time analyzing logical relationships. Toward that end, Sterling Castle's *Logic Gem* helps you build a visual, logical model of a problem, and then prototype and test it. The $99 logic processor will generate a set of rules that express the problem in English or in a high-level computer language.

Logic Gem consists of a Logic Editor, Interpreter, and Compiler. With the Logic Editor, you can create logic tables—spreadsheetlike constructions that encapsulate a set of logical rules. One part of a table contains conditions that can be linked to create a rule, and the other part contains actions that are related to the rules. Once you've defined the rules, the Editor will automatically analyze them, add missing rules, and remove those that are redundant or contradictory.

When you're done, you can interactively test the table with the Interpreter, which supports a mini application language for testing the soundness of the decision-making logic. The Compiler is available to generate source code in C, FORTRAN, Pascal, BASIC, and *dBASE*, and sports options for optimal code-generation. The Compiler will produce a set of English rules that can be used as documentation or as a knowledge base.

As it is, logical analysis is tedious and error prone: it's easy to omit, duplicate, or contradict conditions. *Logic Gem*'s logic tables express a problem visually, making it easy to understand. For programmers, *Logic Gem* can almost bulletproof your source code as well as make it more portable, since logic tables can be used by any language or environment. For the rest of us, *Logic Gem* can make modeling and creating finite state tables and knowledge bases significantly easier.

Logic Gem's rules are formed by linking conditions in the top half of the screen with actions in the bottom.

Logic Gem's weaknesses are few. The generated source code produces nested if-else constructs (the program lacks the ability to generate case statements in C and Pascal, a problem that will be remedied in a subsequent release). And, the documentation and terminology used are too programmer-oriented, although the *Lotus 1-2-3*-like interface is easy enough for anyone to use.

Nevertheless, every programmer and almost anyone else whose responsibilities include planning, designing, and decision making should own a copy of *Logic Gem*. You won't regret it. ■

List price: *Logic Gem*, Version 1.5, $99. **Requires:** 640K RAM, DOS 2.1 or higher. Sterling Castle, 702 Washington St., #174, Marina Del Ray, CA 90292; (800) 722-7853; (800) 323-6406 (in CA).

CIRCLE 436 ON READER SERVICE CARD

UltraVision 2.0 Adds Font Support, New Screen Sizes For VGA Systems

HANDS ON
by Edward Mendelson

VGA users can finally join the crowds at the *UltraVision* party. Until Version 2.0 of Personics' $119.95 video enhancer appeared, only EGA users enjoyed easy access to text screens with more than DOS's standard 80 by 25 characters and with complete control over the color palette. With its new version, *UltraVision* now also packs huge numbers of characters into VGA systems. With a Super VGA card, you can invite as many as 132 by 60 characters to any VGA screen.

UltraVision uses software to perform tricks that look as if they were done with high-priced hardware. The main program is a TSR that takes up 9K to 19K of RAM, but can be tucked into high memory using 386 and 286 memory managers. The program lets you choose from up to 20 text screen sizes (depending on hardware) and 20 styles of screen fonts in up to four heights each. You can use a serif font for standard 80- by 25-character text and a simple Courier font for an otherwise unreadable 132 by 60.

You can also choose from 8 preset but customizable color palettes, and add 8 more of your own. Palettes can support underlining, although it takes some effort. An optional pop-up feature lets you switch or customize palettes while using text or graphics programs. *UltraVision* doesn't offer you control over the screen border.

With EGA/autosync systems, *UltraVision* increases graphics resolution to VGA levels, although most EGA cards require a small hardware booster card sent at no charge when you register. VGA cards don't need the booster card.

UltraVision allows screen sizes up to 94 by 63 characters with a standard VGA system. Add an autosync monitor and you get up to 108 by 43, but with lower resolution. Super VGA cards get 132 by 60 at high resolution with either VGA or autosync monitors.

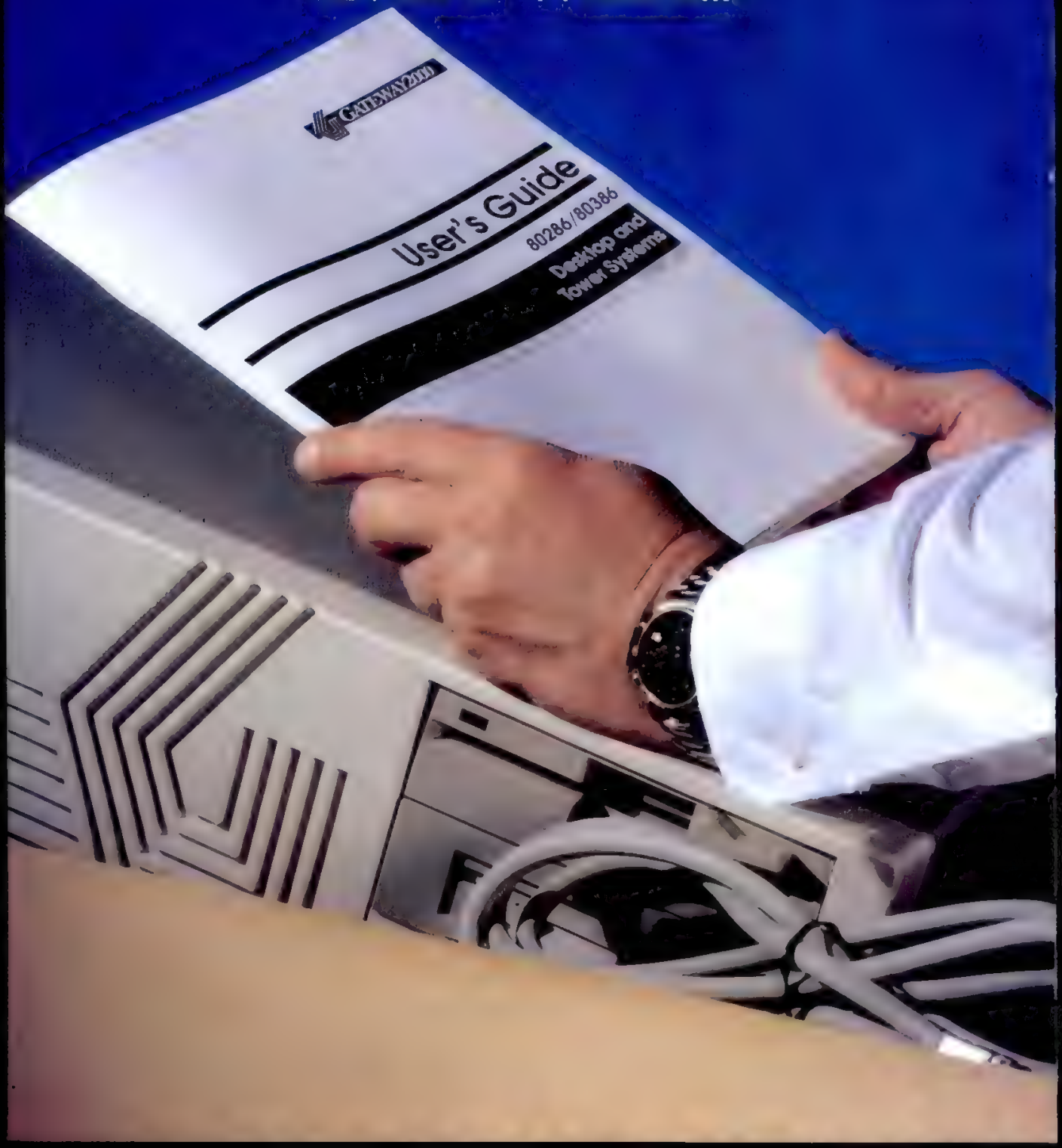
Some applications—notably *WordPerfect*, *Magellan*, and many text editors—automatically adjust to any *UltraVision* screen size. Loaders or drivers that let dozens of other applications adjust to different screen sizes come in the package. Newer drivers are available on CompuServe's PCVENB forum. Some applications insist on an 80-column screen, so *UltraVision* includes a utility that loads them in their preferred size and returns the screen to a larger size afterward.

UltraVision is a technical marvel that's generally effortless to use, and lets an ugly-duckling VGA system discover it's a swan. ■

List Price: *UltraVision*, 2.0, $119.95. **Requires:** 19K free RAM, two disk drives, IBM-compatible EGA or VGA adapters and monitor, DOS 2.0 or later. Personics, 63 Great Rd., Maynard, MA 01754; (508) 897-1575.

CIRCLE 436 ON READER SERVICE CARD

THOUSANDS OF PEOPLE DO THIS EVERY WEEK...



12 MHZ 286 VGA

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- 2 Megs RAM
- 1.2 Meg 5¼" Drive
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- 65 Meg 28ms RLL Drive
- 16 Bit VGA with 512K
- 14" 1024 x 768 Color Monitor
- 1 Parallel & 2 Serial Ports
- 101 Key Keyboard
- MS DOS 3.3 or 4.01

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GATEWAY 386SX

- 2 Megs RAM
- 1.2 Meg 5¼" Drive
- 1.44 Meg 3.5" Drive
- 65 Meg 28ms RLL Drive
- 16 Bit VGA with 512K
- 14" 1024 x 768 Color Monitor
- 1 Parallel & 2 Serial Ports
- 101 Key Keyboard
- MS DOS 3.3 or 4.01

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20 MHZ 386 VGA

- 4 Megs RAM
- 1.2 Meg 5¼" Drive
- 1.44 Meg 3.5" Drive
- 65 Meg 28ms RLL Drive
- 16 Bit VGA with 512K
- 14" 1024 x 768 Color Monitor
- 1 Parallel & 2 Serial Ports
- 101 Key Keyboard
- MS DOS 3.3 or 4.01

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With 64K Cache $2895.00

25 MHZ 386 VGA

- 4 Megs RAM
- 1.2 Meg 5¼" Drive
- 1.44 Meg 3.5" Drive
- 110 Meg ESDI Drive
- ESDI Controller with 32K Cache
- 16 Bit VGA with 512K
- 14" 1024 x 768 Color Monitor
- 1 Parallel & 2 Serial Ports
- 101 Key Keyboard
- MS DOS 3.3 or 4.01

$3095.00

With 64K Cache $3495.00

Due to the volatility of the DRAM market, all prices subject to change

33 MHZ 386 VGA

- 64K Cache RAM
- 4 Megs RAM
- 1.2 Meg 5¼" Drive
- 1.44 Meg 3.5" Drive
- 150 Meg ESDI Drive
- ESDI Controller with 32K Cache
- 16 Bit VGA with 512K
- 14" 1024 x 768 Color Monitor
- 1 Parallel & 2 Serial Ports
- 101 Key Keyboard
- MS DOS 3.3 or 4.01

$3995.00

25 MHZ 486 VGA

- 4 Megs RAM
- 1.2 Meg 5¼" Drive
- 1.44 Meg 3.5" Drive
- 150 Meg ESDI Drive
- ESDI Controller with 32K Cache
- 16 Bit VGA with 512K
- 14" 1024 x 768 Color Monitor
- 1 Parallel & 2 Serial Ports
- 101 Key Keyboard
- MS DOS 3.3 or 4.01

$5295.00

This device has not been approved by the Federal Communications Commission. This device is not, and may not be offered for sale or lease, or sold or leased until the approval of the FCC has been obtained.

WE'LL TELL YOU WHY

Ray: That's where we shine. Gateway's tech support is the best in the industry. We know what we're talkin' about, but most importantly, we care. We'll bend over backwards to take care of you. You won't hear us saying, "Sorry ma'am, that's a software problem." We don't care whose problem it is. If the machine is not working for you, we'll do everything in our power to get you up and running.

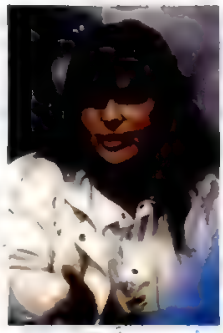
Ted: What if you can't fix a problem over the phone?

Ray Kayl, Technical Support Manager

Ray: Then we can send a technician to almost anyplace in the nation.

Ted: Kathy—bet you thought I forgot you—what about customer service?

Kathy: Customers get very personal service here. When you call Gateway, you'll be



Kathy Skidmore, Customer Service Manager

assigned to one customer service representative who will follow your order from start to finish. Your personal rep will make a special effort to get to know you and make sure you're completely satisfied.

Norm: Hey, this sounds almost too good to be true.

Ted: Some people think that. But our customers don't—ask them. They know Gateway 2000 is the best value in the industry.

Norm: Do we have an ad yet?

Ted: Yeah, I think so. All I have to do is cut some prices on our systems. Then get ready for a really hot summer...(Tape End Indicator.)

Norm Watt, Vice President

GATEWAY 2000

"You've got a friend in the business."

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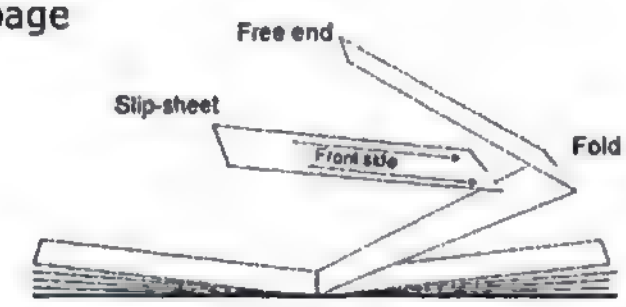
CIRCLE 364 ON READER SERVICE CARD

Folded edge of the page

GbsSlipSheet-001

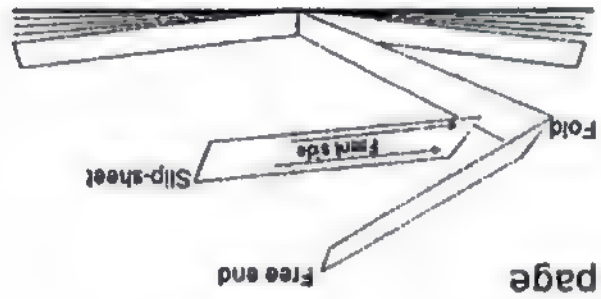
Foldout slip-sheet

1. Open the foldout page
2. Insert this sheet with
   1. Front side touching the free page
   2. Arrow pointing to the fold
3. Slice the folded edge
4. Close the page and slip-sheet



Inverted Foldout slip-sheet

1. Open the foldout page
2. Insert this sheet with
   1. Front side touching the free page
   2. Arrow pointing to the fold
3. Slice the folded edge
4. Close the page and slip-sheet



Copyrighted mater

GbsSlipBack-001B

Back

1. Follow instructions on the other side

Inverted Back

1. Follow instructions on the other side

PULL UP A CHAIR AND

Ted: OK, we're putting together another ad for the magazines and I thought you should be the ones to write it.

Todd (laughing): Hey, Ted, I'm no writer.

Ted Waitt, President

Ray: Me neither. Don't you s'pose we could hire somebody to write our ads? (Laughter.)

Ted: No, because we've always been straight forward in our advertising. I've analyzed the market and I can't understand why anyone would buy a computer from anyplace except Gateway. Now I know you all agree with me, so I want you to tell the world what you can do for them. Just straight talk from a friend in the business. I'm recording this—

Troy: Is this legal?

Ted: —and I'm gonna give the tape to word processing for a transcription. And that's gonna be our ad.

Todd Osborn, Sales Manager

Norm: This oughta be good! (Laughter.)

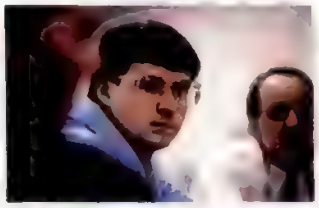
Ted: Todd, you're on. I'm looking for a computer system. Why should I buy from Gateway 2000?

Todd: Because Gateway has the best value. We lead the market in price, quality and service. It's that simple. You wanta get the best system for the best price from a company you can depend on? Then buy from Gateway 2000.

Troy: Yeah, shop around. But don't be fooled by stripped-down systems. Compare Gateway feature for feature and we blow the competition away.

Norm: And read the reviews. Our systems out-perform machines that cost twice as much.

Ted: Troy, you're on. You run the plant so you tell me what kind of quality I can expect?

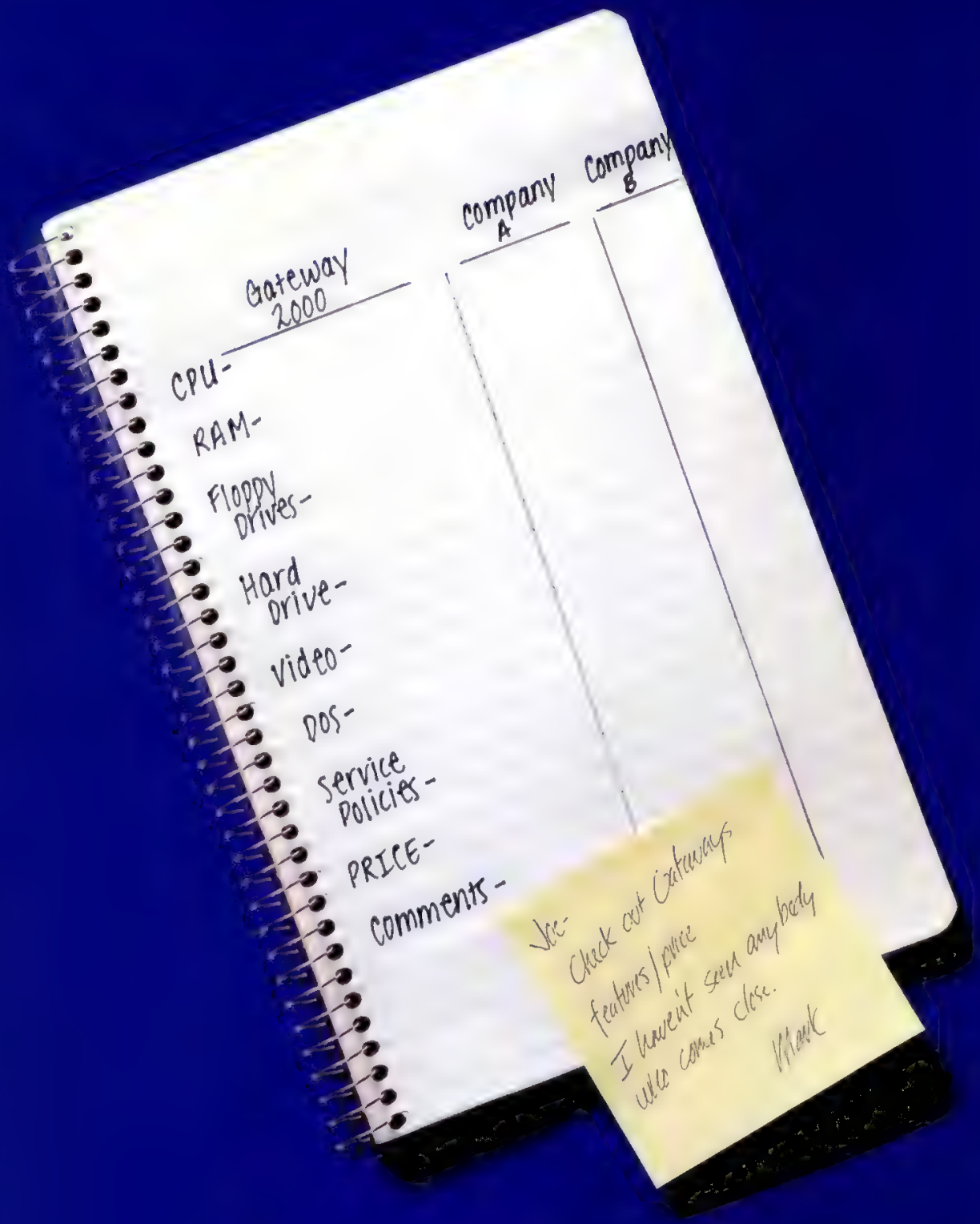

Troy Miller, Plant Manager

Troy: Well we use a component that's not very common today—pride. Each machine that goes out the door is custom-built by one person. That person's pay is determined by how satisfied you are as a customer. We use only top-of-the-line components. You combine that with the midwest work ethic and you've got an unbeatable combination.

Ted: OK, Gateway's got great prices on quality systems. But we can't guarantee everyone that they'll never have a problem.

Ray: If we could, I'd be out of a job. (Laughter.)

Ted: Yeah, Ray. Tell me about your job. What happens if a customer does have a problem?



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LaserJet Fonts Put Your Keyboard on Paper

HANDS ON
by Edward Mendelson

If the users who read your software manual call to complain that they can't find the "any" key, you can clear up the confusion with a soft font that reproduces the keycaps on the keyboard. If you use a LaserJet or compatible, you can now get a variety of keycap fonts. And if you use *WordPerfect* 5.*x*, you can use an even better solution in the form of EKD's $69.95 *KeyWords*.

KeyWords uses a set of *WordPerfect* graphics files instead of a soft font. A macro lets you insert an image of any key by entering a letter or number or a name like PrtSc or SysRq. You get 12 function keys, four versions of the Spacebar, three versions of the Enter key—even Left Shift and Right Shift. Nonkeycap characters like fractions and the copyright symbol are a small bonus.

Normal *WordPerfect* menus let you set the default size for the keycaps or enlarge or reduce individual letters. The preview screen shows you how the graphics will look on paper, but the editing screen shows each graphic as a box. The one flaw in *KeyWords* is a slight inconsistency in the baseline of the text in different keycaps like Ctrl and Ins.

If you don't use *WordPerfect*, or prefer soft fonts, the best choice is SoftCraft's *Keytops*, sold in 14- and 36-point sizes at $15 each. You'll also need one of SoftCraft's installation programs ($95 and up) for *WordPerfect*, *Microsoft Word*, *Microsoft Windows*, or *Ventura Publisher*.

SoftCraft offers a cleanly designed font with a three-dimensional effect. All characters are the same size, so the Spacebar is no wider than the letter keys; you don't get F11 or F12.

Elfring Soft Fonts' $45 *KeyCaps* make you build your own keycaps. You get five sizes of Helvetica with horizontal lines above and below each letter. By typing a parenthesis, then "Esc," then another parenthesis, you create a reasonable facsimile of the Esc key. Another $45 disk has white-on-black fonts; $65 gets both sets. Drivers for major word processors are $15 each, and Elfring supplies equivalent fonts for the DeskJet.

Acorn Software's $60 *Computer Keys* font comes in five sizes and has only 30 characters: F1 through F10 and some name and arrow keys, but no letter keys. Well drawn, but there aren't enough of them. ■

List Price: *KeyWords*, $69.95. EKD, 770 Middle Country Rd., P.O. Box Y, Selden, NY 11784; (516) 736-0500.

CIRCLE 430 ON READER SERVICE CARD

Keytops, $15. SoftCraft, 16 N. Carroll St., #500, Madison, WI 53703; (800) 351-0500.

CIRCLE 431 ON READER SERVICE CARD

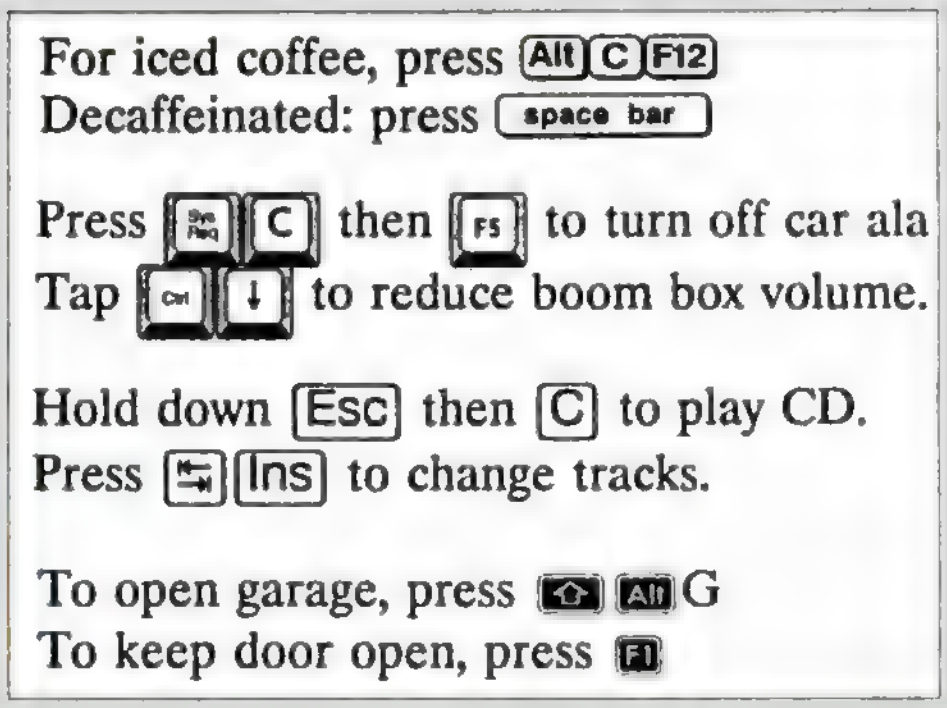
KeyCaps, $45. Elfring Soft Fonts, P.O. Box 61, Wasco, IL 60183; (708) 377-3520.

CIRCLE 432 ON READER SERVICE CARD

Computer Keys, $60. Acorn Software, 4219 W. Olive Ave., #2011, Burbank, CA 91505; (213) 876-5237.

CIRCLE 433 ON READER SERVICE CARD

Requires: For *KeyWords*: *WordPerfect* 5.*x*. For *Keytops*, *KeyCaps*, or *Computer Keys*: LaserJet or compatible printer.



From top to bottom, a sample of keycap fonts from EKD, SoftCraft, Elfring, and Acorn.

The Complete Fax/Portable: External Fax Package for Hard-Disk-Based Portables

HANDS ON
by M. David Stone

Despite its name, The Complete Fax/Portable (CFAX/P), the latest offering from The Complete PC, is better characterized as an external 9,600-bps Group III fax package than a portable one.

Weighing 8 ounces with a 9-volt battery, or 1 pound 2 ounces with an AC adapter and a 36-inch serial cable, the $499 CFAX/P is certainly light enough to be portable. And at 3 by 1 by 5¾ inches, it is small enough to fit in the side pocket of your PC's carrying case.

But compared with Touchbase Systems' $699 WorldPort 2496 Fax/Data Modem, which weighs 7 ounces with a 9-volt battery and measures 2 11/16 by 1 by 4⅞ inches and includes a 2,400-bps data modem, the CFAX/P seems noticeably heavier and bigger.

Ironically, it's the software side of the CFAX/P package that may limit its use with portables. The CFAX/P files take up over 1.1MB of hard disk space, and its installation program requires 3MB of available storage on the target disk. Obviously, this rules out any portable that doesn't have a hard disk. Even those that do may not have 3MB of precious disk space to spare.

What you get for all this disk space is software that makes few compromises. You can have up to 999 entries per phonebook and up to 999 distribution lists (99 names each). You can also create ad hoc distribution lists; convert faxes to and from ASCII, .CUT, .PCX, .MSP, and .TIF formats; and create a fax by capturing print output from any program with an Epson FX printer driver.

The CFAX/P software looks much like the software that comes with the vendor's Complete Fax/9600, a similar package that puts a fax modem on an internal card. CFAX/P differs in that when sending or receiving faxes, it takes over your PC, functioning as a TSR rather than as a true background program.

All told, the CFAX/P is designed as much for desktop PCs as for portables. If you have a hard-disk-based portable and need fax capability, the CFAX/P is worth considering. But if you have a free comm port on your desktop PC, it may be even more interesting as a way to add Group III fax capabilities without using up an expansion slot. ■

List Price: The Complete Fax/Portable, $499. **Requires:** IBM PC, XT, AT, PS/2, or compatible; 640K RAM, hard disk with 3MB of available space, serial port, DOS 3.11 or later. CGA, EGA, VGA, or Hercules graphics adapter card required for viewing faxes. The Complete PC Inc., 1983 Concourse Dr., San Jose, CA 95131; (408) 434-0145.

CIRCLE 434 ON READER SERVICE CARD

The Product Is Great, The Price

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- 2 SERIAL PORTS, 1 PARALLEL PORT AND 1 GAME PORT
- 8 EXPANSION SLOTS (2-8 BIT, 6-16 BIT)
- KEYBOARD SELECTABLE CPU SPEED
- REAL-TIME CLOCK/CALENDAR AND BATTERY
- SUPPORTS 80287 CO-PROCESSOR AT 10MHz OR 12MHz
- LIM EMS V.4 DRIVER INCLUDED
- 3 ACCESSIBLE 5¼" HALF-HEIGHT DRIVE BAYS
- 1 HIDDEN 3½" DRIVE BAY
- 200W POWER SUPPLY
- SYSTEM BOARD MADE IN U.S.A.
- 16⅛" W x 6" H x 16¾" D
- ***SPECIAL FEATURE:** THIS SYSTEM CAN BE UPGRADED TO A 386/SX USING CPU MODULE*

PC MAGAZINE *"Don't pass over the CPU 286 12MHz" —Sept 1989*

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- 2 SERIAL PORTS, 1 PARALLEL PORT AND 1 GAME PORT
- 8 EXPANSION SLOTS
- KEYBOARD SELECTABLE CPU SPEED
- REAL-TIME CLOCK/CALENDAR AND BATTERY
- SUPPORTS INTEL 80387 & WEITEK 3167 CO-PROCESSORS
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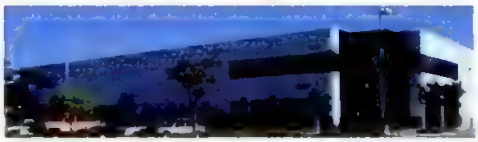

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CIRCLE 205 ON READER SERVICE CARD

by
Matthew J. Ross

New&Improved

News of Announced Products and Upgrades

HOT PROSPECT

LOTUS 1-2-3/G SPREADSHEET FOR OS/2

Lotus Development's market-leading spreadsheet is now available for the OS/2 Presentation Manager. *Lotus 1-2-3/G* is a graphical implementation of *1-2-3* that retains full keyboard support and first-letter commands while adding a mouse interface with cascading pull-down menus and dialog boxes, as well as user control of fonts, borders, and color palettes.

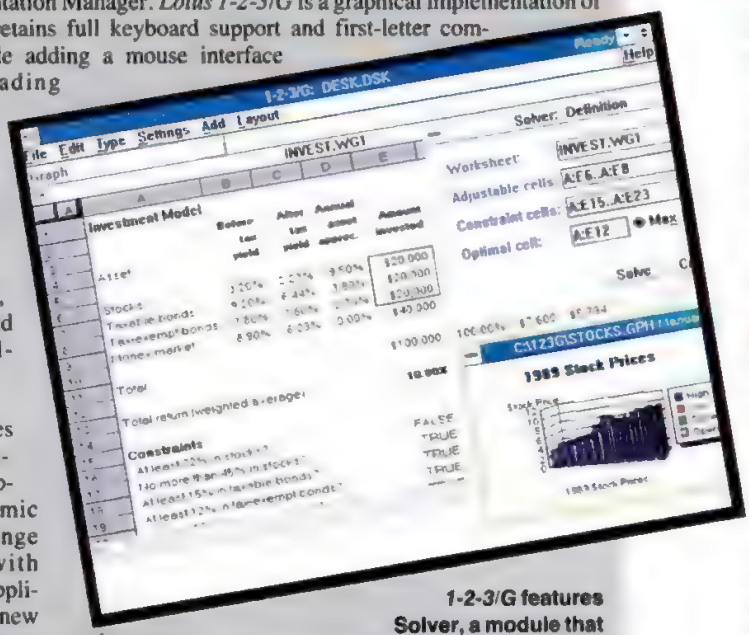
Lotus 1-2-3/G uses multithreading and supports dynamic data exchange (DDE) with other PM applications. A new feature, Solver, permits users to define a set of rules within a spreadsheet model. Solver will then compute all of the existing possibilities that fulfill these rules as well as offering a best-case scenario for "what if" projections.

Additional features include support of Lotus' DataLens technology for accessing external data sources, file linking across worksheets, and group functions for connected worksheets. *Lotus 1-2-3/G* shares the macro language of Release 3 for DOS and features a macro translator for earlier releases of *Lotus 1-2-3*.

List Price: *Lotus 1-2-3/G*, $695; upgrades from Release 2.2, $75; other *1-2-3* upgrades, $150.

Requires: 4MB RAM, OS/2 1.1 or later. 386 computer with 5MB RAM recommended. Lotus Development Corp., 55 Cambridge Pkwy., Cambridge, MA 02142; (617) 577-8500.

CIRCLE 440 ON READER SERVICE CARD



1-2-3/G features Solver, a module that computes outcomes to a given set of constraints within a spreadsheet.

Okidata Unveils Three Laser Printers

NEW

Okidata, a leader in the dot matrix market, has thrown its hat into the laser printer market with three new products. The OkiLaser 800 is an 8-page-per-minute (ppm) unit featuring 512K RAM expandable to 4.5MB, with LaserJet Series II, Diablo, and IBM Proprinter emulations, plus 26 resident fonts in four type faces. The OkiLaser 800 is upgradable to support Adobe PostScript.

The OkiLaser 820 offers 13 Bitstream scalable outline fonts and 26 bitmap fonts for HP compatibility. The OkiLaser 840 is an 8-ppm Adobe PostScript laser that also offers software switching between LaserJet Series II and Diablo emulations. The OkiLaser 840 comes standard with 2MB RAM, expandable to 4MB, and the AppleTalk interface.

The OkiLaser series implements Okidata's LED technology, and features a nearly straight paper path as well as a standard 200-sheet letter-sized paper tray. All three printers have two proprietary Okidata font card slots.

List Price: OkiLaser 800, $1,795; OkiLaser 820, $2,295; OkiLaser 840, $3,595. Okidata, 532 Fellowship Rd., Mount Laurel, NJ 08054; (609) 235-2600.

CIRCLE 445 ON READER SERVICE CARD

Twisted-Pair Ethernet Available For Micro Channel

NEW

The twisted-pair Ethernet market is growing rapidly, and **Frontier Technologies** has introduced a new Micro Channel product for use with TCP/IP and OSI protocols. Frontier's 802.3/TP-MCA network card features an on-board 10-MHz 80186 microprocessor for off-loading complex protocol instruction processing from the host CPU.

Frontier's *Super-TCP/IP* network software downloads to the 802.3/TP-MCA to improve performance, increasing speed by reducing transfer times. The 802.3/TP-MCA currently supports the LattisNet twisted-pair technology, but Frontier will upgrade the card to include 10BaseT by the end of the second quarter of 1990.

List Price: 802.3/TP-MCA, $895. Frontier Technologies Corp., 3510 N. Oakland Ave., Milwaukee, WI 53211; (414) 964-8689.

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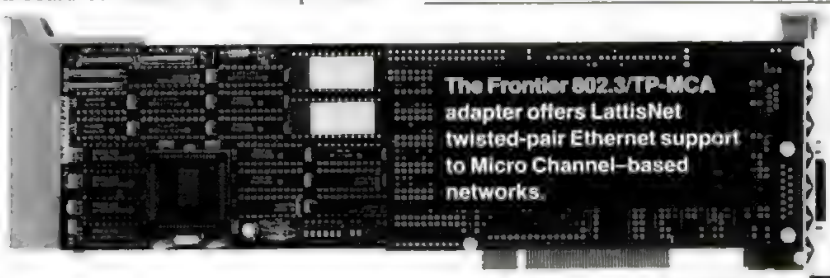

The Frontier 802.3/TP-MCA adapter offers LattisNet twisted-pair Ethernet support to Micro Channel–based networks.

Compaq Adds Small-Footprint 25-MHz 386 to Product Line

NEW

Bolstering its desktop lineup, **Compaq Computer Corp.** has added the 25-MHz 80386-based Deskpro 386/25e. The system integrates 16-bit VGA circuitry onto the system board, comes standard with 4MB of RAM, and features the newer, reduced-footprint Compaq case design at a lower price than the older Deskpro 386/25. Internal expansion is possible through the four industry-standard expansion slots, four half-height drive bays, and system memory expandable to 16MB.
List Price: Compaq Deskpro 386/25e with 4MB RAM, 120MB hard disk, 1.2MB 5.25-inch floppy disk drive, $8,499. Compaq Computer Corp., 20555 FM 149, P.O. Box 692000, Houston, TX 77269; (713) 370-0670.

CIRCLE 444 ON READER SERVICE CARD

The Deskpro 386/25e features a small-footprint design and integrated VGA circuitry.

IMPROVED

***Entry Level System NetWare Level I*, Version 2.12**—To help make life easier for the part-time network administrator in small offices, Novell has simplified its entry-level product. *ELS NetWare Level I*'s new installation program requires users to make fewer decisions. Performance has been improved, according to Novell, and with Version 2.12, IBM PS/2 Models 30 286, 50Z, 55SX, and 70 can be used as file servers. Novell has added driver support to include all *NetWare* IPX LAN drivers supported in *Advanced NetWare* and *SFT NetWare*. In addition, the server can now operate in both dedicated and nondedicated mode. Other enhancements include UPS monitoring, a bundled tape backup program, as well as advanced features from *NetWare*, Version 2.15, such as resource accounting, disk user restrictions, security and log-in restrictions, and over-the-wire password encryption. *Entry Level System NetWare Level I*, Version 2.12, lists for $795 with upgrades from Version 2.0a available for $380. Novell Inc., Provo, Utah; (801) 379-5900.

***Applications Manager*, Version 2.2**—Intelligent Environments offers support for OS/2, Version 1.2, with the latest release of its development tool for Presentation Manager–based applications. Improvements fall under two categories: data integration and user features. Data integration improvements include multiuser support for IBM's Data Manager and Microsoft's SQL Server, enhanced 3270/5150 terminal emulation, APPC support, and improved data structure support. User enhancements include greater support of fonts and colors, multidocument interface support (MDI), multicolumn list boxes, and multiwindow support. The professional version of *Applications Manager* lists for $5,000 while *AM Personal* is priced at $695. Intelligent Environments, Tewksbury, Mass.; (508) 640-1080.

***Solomon III*, Version 6.1**—TLB Inc. has added a multilevel fault-tolerance system to its network accounting package. Physical fault tolerance ensures that when a system failure occurs, no physical records are placed in the database without their related indexes and pointers. Logical fault tolerance permits only complete transactions to be returned to the database. Process fault tolerance resumes an operation from the point where it was interrupted, while media fault tolerance uses the existing transaction log of entered data to reconstruct lost data. *Solomon III*, Version 6.1, retails for $795 for a three-user system. TLB Inc., Findlay, Ohio; (800) 879-2767, extension 782.

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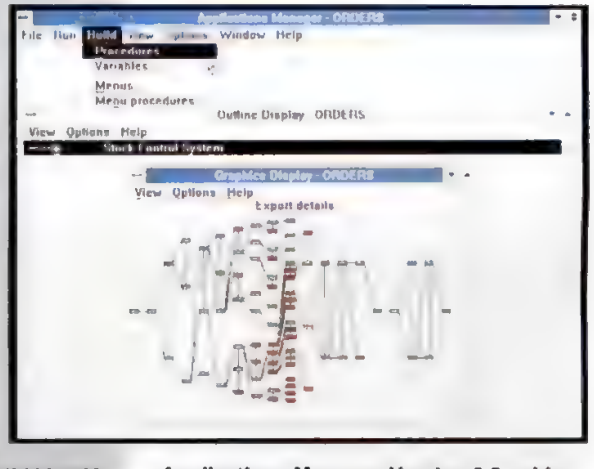

***Applications Manager*, Version 2.2, adds enhanced graphics with greater color support and improved windowing.**

Racal-Vadic Introduces Multiuser Fiber-Optic Modems

NEW

Taking advantage of the benefits available over conventional copper cable, **Racal-Vadic** has developed three families of fiber-optic modems and multiplexers. According to the manufacturer, the Racal-Vadic Fiber Optic 1000, 6000, and 8000 Series support a wide variety of fiber-optic-based communications environments, including local area network (LAN) communications, shared mainframe services, and T1/E1 networks. Fiber-based modems offer not only greater carrying capacity, but also enhanced data security, immunity to electromagnetic interference, and much greater flexibility in installation over copper-cable-based products.

The Racal-Vadic 6000 Series offer synchronous or asynchronous communications up to 19,200 bits per second (bps) and is compatible with any Racal-Vadic multiplexer for incorporation into existing networks. The 8000 Series of multiplexers provide multiple-channel support to remote users in mini- and mainframe environments. 8-, 16-, and 32-channel configurations are available, while the 1000 Series features modems and multiplexers that conform to the Bell DS-1 (T1) and CEPT G.703 (E1) protocols.
List Price: Racal-Vadic Fiber Optic 1000, 6000, and 8000 Series modems and multiplexers: 1000 Series, $1,080 to $9,205; 6000 Series, $75 to $1,050; 8000 Series, $1,090 to $2,650. Racal-Vadic, 1525 McCarthy Blvd., Milpitas, CA 95083; (408) 432-8008.

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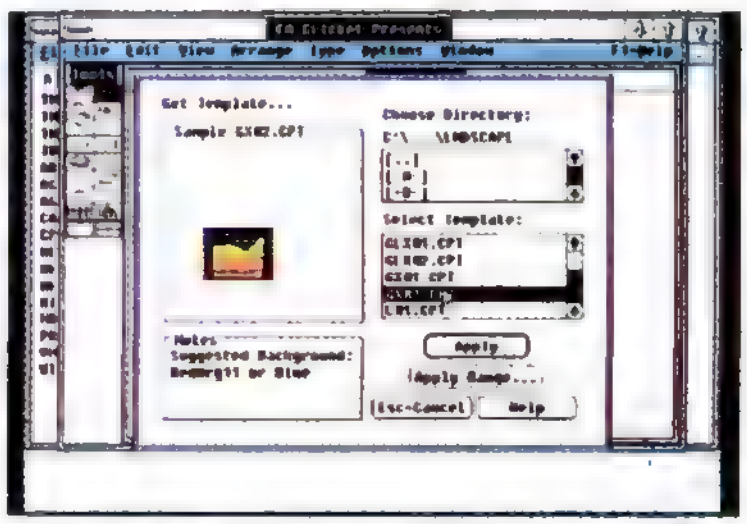
CONTINUED FROM PAGE 54

***ColoRIX VGA Paint*, Version 1.3**—RIX Softworks has extended the compatibility of its paint program both forward and backward. *VGA Paint* now supports video adapters with one megabyte of video memory to create images in 1,024 by 768 resolution with 256 colors. EGA system support has been added as well. Other enhancements include support of CompuServe's .GIF format and a dithered Targa import filter, a new screen loader, additional color printer support, and Kodak film recorder support. The *VGA Paint* DOS shell now has two modes: text and graphics. An optional scanning module is available for Sharp, Mitsubishi, Howtek, Microtek, and Epson color scanners. *ColoRIX VGA Paint*, Version 1.3, retails for $199. RIX Softworks Inc., Irvine, Calif.; (714) 476-8266.

***Primavera Project Planner*, Version 4.0**—Primavera Systems has added multiuser support under Novell's *Advanced NetWare* 2.1 or later. *Primavera Project Planner* with *Primavision* now features record and file locking; an unlimited number of users may work on the same project with the network administrator determining the rights. Two other network features are "P-Mail" and an electronic bulletin board. Primavera's *Primavision* graphics software now can print or plot three projects simultaneously for comparison. Users have greater control over output, and PostScript support has been added. Version 4.0 also includes suspend and resume dates to better track the history of projects. Additional features include interruptible activity scheduling and flag symbols. Together *Primavera Project Planner* and *Primavision* cost $4,000. Primavera Systems Inc., Bala Cynwyd, Pa.; (215) 667-8600.

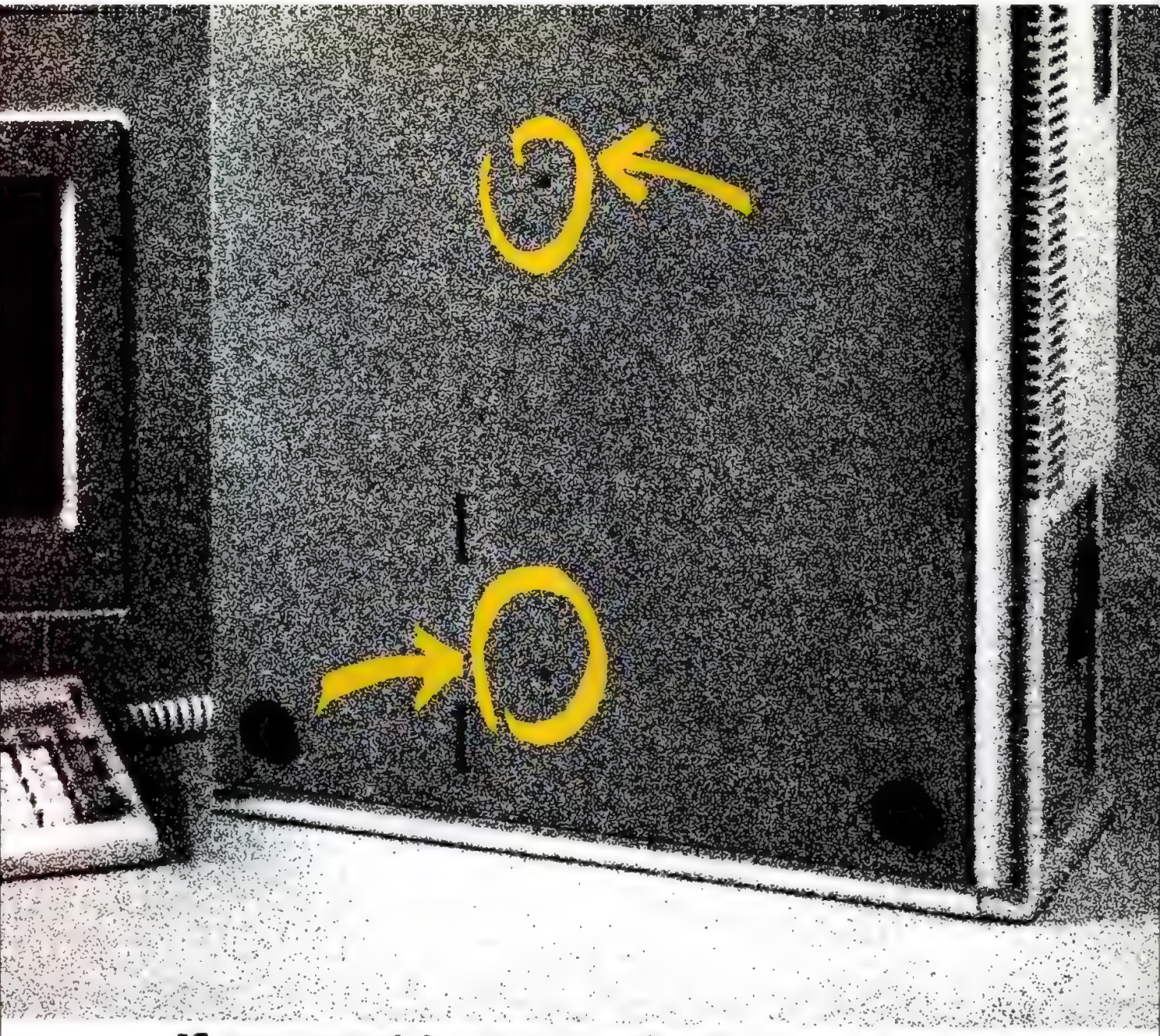
***CA-Cricket Presents, Graph*—** Computer Associates has acquired the rights to *Xerox Presents* and *Xerox Graph*, and both packages now offer more features than their respective Macintosh counterparts. *CA-Cricket Graph* now implements the Nimbus Q scalable font-outline technology, which uses the same font outlines both on-screen and at the output device for WYSIWYG test placement. Additional improvements include more coherent documentation and on-line help, as well as .CGM file export. Many of the earlier bugs have been fixed and performance boosted, according to Computer Associates. *CA-Cricket Presents* also implements Nimbus Q, and adds virtual memory support, more export file formats (color TIFF and .CGM), and manual kerning. *CA-Cricket Graph* retails for $195, *CA-Cricket Presents* for $495. Computer Associates International Inc., Garden City, N.Y.; (516) 227-3300.



***CA-Cricket Presents* features templates designed by artists to help you create smart-looking presentations.**

***FormWorx with Fill & File*, Runtime Version**—FormWorx has announced a cost-effective means of filling in forms with a runtime version of its software. The runtime version does not include any of the form design or editing capabilities, but users can input and edit data on screen and print any forms that have been created with *FormWorx with Fill & File*. The runtime version retails for $193 for up to six users and requires one fully working copy of *FormWorx with Fill & File*. FormWorx Corp., Waltham, Mass.; (617) 890-4499.

***PC Tools Deluxe*, Version 6**—Central Point Software's utility software offers 70 new features and improvements. DiskFix is a new disk-repair utility whose doctoring capabilities include fixing file allocation table (FAT) errors, corrupt boot sectors, and cross-linked files. *PC Tools Deluxe* adds tape support and incremental/appended backups for more efficient backups. Other improvements include a DOS command line within the DOS shell; 20 new file viewers; file transfer capability through an integrated version of Traveling Software's *Lap-Link*; telecommunications support; a user-customizable interface with password security; and improved disk caching. *PC Tools Deluxe*, Version 6, retails for $149. Upgrades are available for $30 plus shipping costs. Central Point Software, Beaverton, Oreg.; (503) 690-8090.



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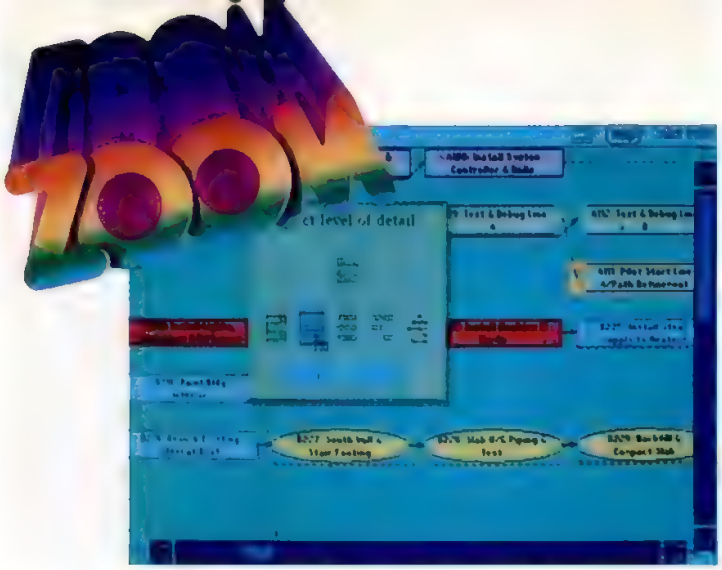
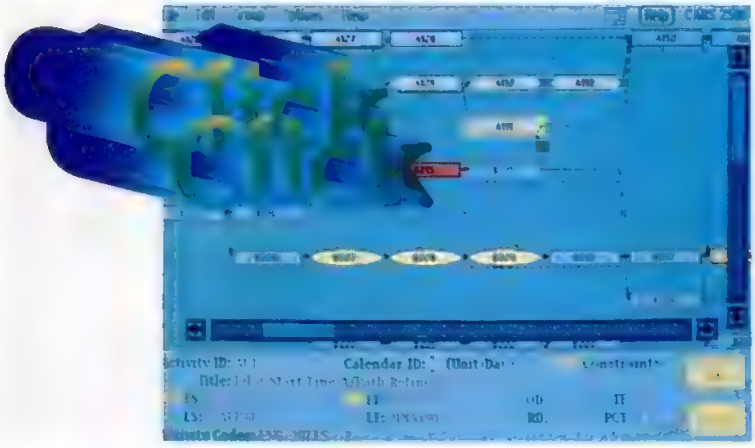
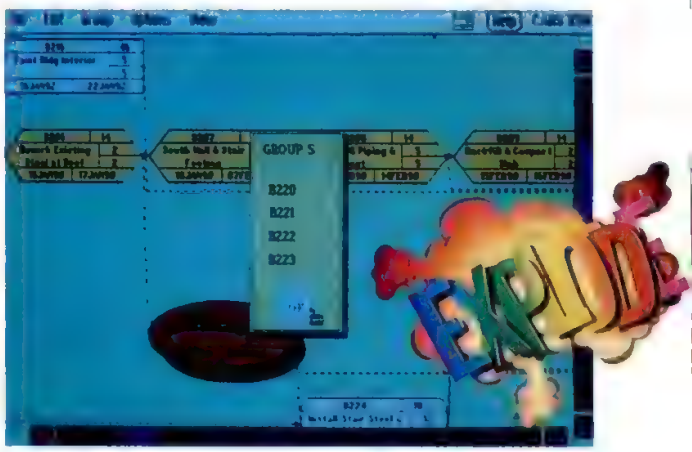


Zoom — five levels of detail for your network, from bird's-eye to close-up.

Pop — highlights all predecessor-successor relationships and lets you click your way along any activity path.



Click-Click — use double clicks to add activities, define relationships, and modify activity data.



Explode — The Collapse command compresses several activities into one; Explode redisplays activities in their original positions.

Primavera introduces some important new project management terminology.

Primavera Project Planner® 4.0 works like you think. Visually. Graphically. Intuitively. As quickly as "pop", "click", "zoom"! Keeping you in touch with the big picture while giving you instant access to all the details.

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PC

1-2-3 Add-In Provides HP DeskJet Support

NEW

Intex Solutions has created *DeskSet*, an add-in for *Lotus 1-2-3* that provides software support for the Hewlett-Packard DeskJet and DeskJet Plus printers. Users can switch fonts within a spreadsheet to set off titles and column headings, and *DeskSet* supports the 16 fonts built into the PaintJet printers plus additional fixed and proportional font types.

With *DeskSet*, you can print in portrait or landscape mode in the same spreadsheet, control line spacing, underline, and save printer settings for each worksheet. Another feature is document preview via a rudimentary window that displays the numbers of rows printed, character width, page length and size, margins, headers, and footers. *DeskSet* works with *Lotus 1-2-3*, Release 2.*x*, and with all versions of *Symphony*.

List Price: *DeskSet*, $95 plus a $5 shipping charge. **Requires:** 64K of additional RAM, *Lotus 1-2-3* or *Symphony*, DOS 2.0 or later. Intex Solutions Inc., 161 Highland Ave., Needham, MA 02194; (617) 449-6222.

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PractiDisk Extra Density Drive Doubles Floppy Disk Storage

NEW

Taking advantage of the newest generation of floppy disk technology, **Practical Computer Technologies'** PractiDisk ED offers a 1-megabit-per-second transfer rate and 2.88MB floppy disk capacity, effectively doubling performance compared with a high-density 3.5-inch floppy disk.

The PractiDisk ED mounts internally in any 3.5-inch drive bay; it is also available as an external subsystem. PractiDisk works with extra-high-density (ED) disks, and it can read and write both high- (HD) and double-density (DD) disks. The included UMFC-Plus controller also supports a 360K/1.2MB 5.25-inch floppy disk drive. The memory-resident driver takes 4K to operate and works with DOS 2.0 or later. ■

List Price: PractiDisk ED Micro Drive external subsystem, $598, internal subsystem, $478. Practical Computer Technologies Inc., 3972 Walnut St., Fairfax, VA 22030; (703) 385-3332.

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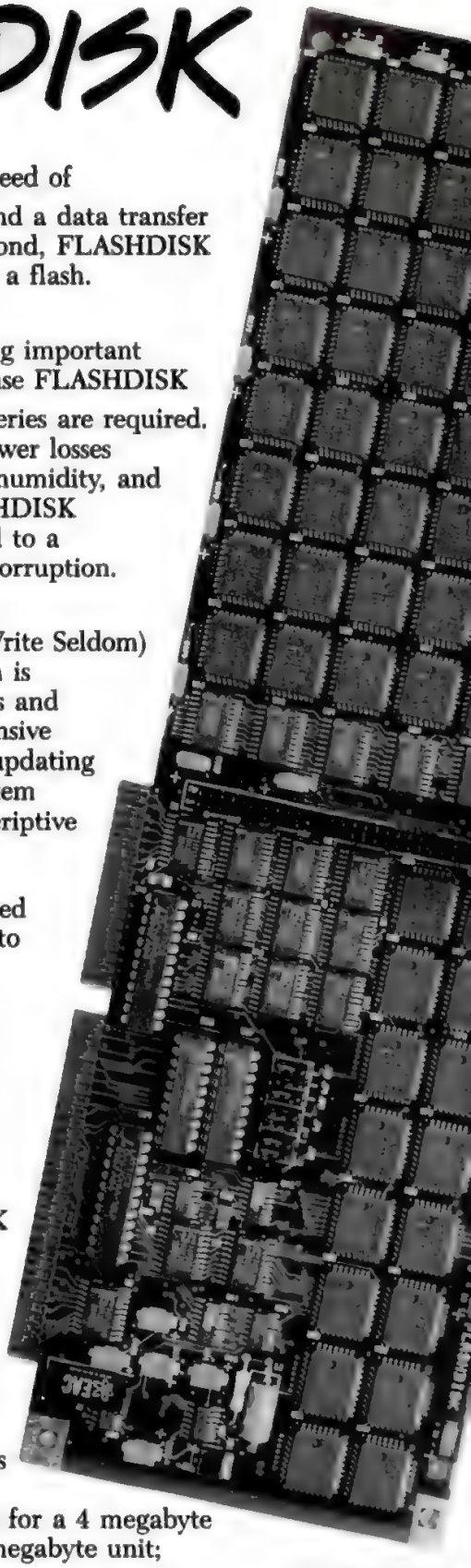
FLASHDISK



FAST. With an access speed of *240 nanoseconds* and a data transfer rate of 2048 kilobytes per second, FLASHDISK can boot up your software in a flash.

SAFE. The fear of losing important data can be eliminated because FLASHDISK is *nonvolatile*. No batteries are required. Data saved can withstand power losses and surges, vibrations, dust, humidity, and extreme temperatures. FLASHDISK can be removed and returned to a system without data loss or corruption.

ROWS. (Read Often Write Seldom) describes FLASHDISK which is perfect for software programs and data bases that are read intensive and may require occasional updating but need to be safe from system crashes. Write Seldom is descriptive because the write times are 1 megabyte per minute, and the chips have only been tested from one hundred thousand to one million rewrites without failure.

EASY. Any IBM compatible 16 bit computer can use a FLASHDISK. Installation is simple and no new commands need be learned because FLASHDISK uses *standard DOS commands*. The only exception is that once data is intentionally deleted, it is truly erased.

PRICE. FLASHDISK's retail price is $1500.00 for a 2 megabyte unit, $2700.00 for a 4 megabyte unit, and $4900.00 for a 8 megabyte unit; each unit comes with a one year warranty.

Call for more information or technical questions? *1-800-662-6802* or FAX 205-533-6353

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DIGIPRO

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PC Magazine says, "Northgate's SlimLine 320 ..."

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More Storage! More Performance!

Upgrade to our new super fast Super Max™ 200Mb Hard Drive with 15ms Access.

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You want maximum performance and value in a space-saving desktop case. You get it in a Northgate SlimLine 320. It packs all the power of a full-size 386 into a performance package only 4.25" high and 16.5" square. And, at just 23 pounds, you can move it with ease.

PC Magazine said: "(SlimLine) doesn't take up a lot of room...but it delivers plenty of computer for a price you might expect to pay for a 286 system."

The heart of the system is a new Northgate proprietary motherboard with built-in hard and floppy disk controllers, 2 serial and 1 parallel port and 16-bit VGA video. Smaller than a sheet of legal paper. It gives you a host of features that are add-ons in others' systems. Even our clock/calendar method is guaranteed for 5 years without using old-fashioned batteries. And with five expansion slots, you have plenty of room for all your peripherals.

Use it at office or home. Run the latest multi-tasking applications under Windows® or Northgate's OS/2.® Crunch numbers on the biggest spread sheets. Sort, search and select data in your databases at the blink of an eye. Use it as a file server, and if you're looking for high performance terminals in a network environment, *SlimLine 320* is an ideal solution.

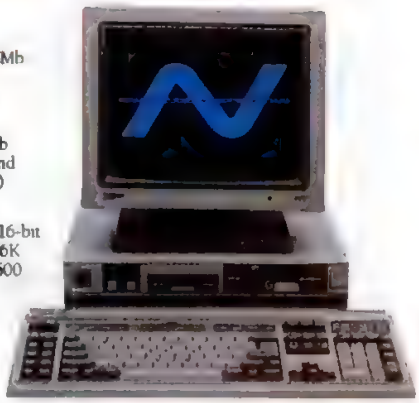
When it's this good, this cheap, why buy less?"*

December 26, 1989

And remember... your Northgate SlimLine 320 is backed by expert technical support any time you need it. Call toll-free, 7 days a week, 24 hours a day. On-site deskside service is available 5 days a week (to most locations) if we can't solve your problem over the phone.

SYSTEM FEATURES

- Intel 80386-20MHz microprocessor
- 2Mb of RAM, expandable to 8Mb on motherboard
- 40Mb hard drive with 28ms access time
- 3 25" 1 44Mb and 5.5" 1.2Mb Floppy Disks (reads, writes and formats low density diskettes)
- Page mode memory system
- Integrated high performance 16-bit VGA color controller with 256K video RAM supporting 800x600 line resolution
- Integrated high performance floppy and hard disk controller on the motherboard
- 1 parallel and 2 serial ports
- 5 expansion slots (3 full-size 16-bit I/O boards; 2 half-length 8-bit)
- 14" NEC 2A VGA Color Monitor
- Exclusive *OmniKey*/PLUS Keyboard
- DOS 4 0 and GW Basic Software Installed
- FCC Class B Certified



TEST A SLIMLINE 320
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FOR 30 DAYS

PC Magazine December 26, 1989 reviewed the Northgate MicroStation 386/20. This system has been upgraded and is now named the "SlimLine 320."

Of course, SlimLine 320 comes with a 1-year limited warranty on parts and labor; 5-years on the *OmniKey* keyboard. If a part fails, we'll ship a replacement to you overnight at our expense before you return your part.

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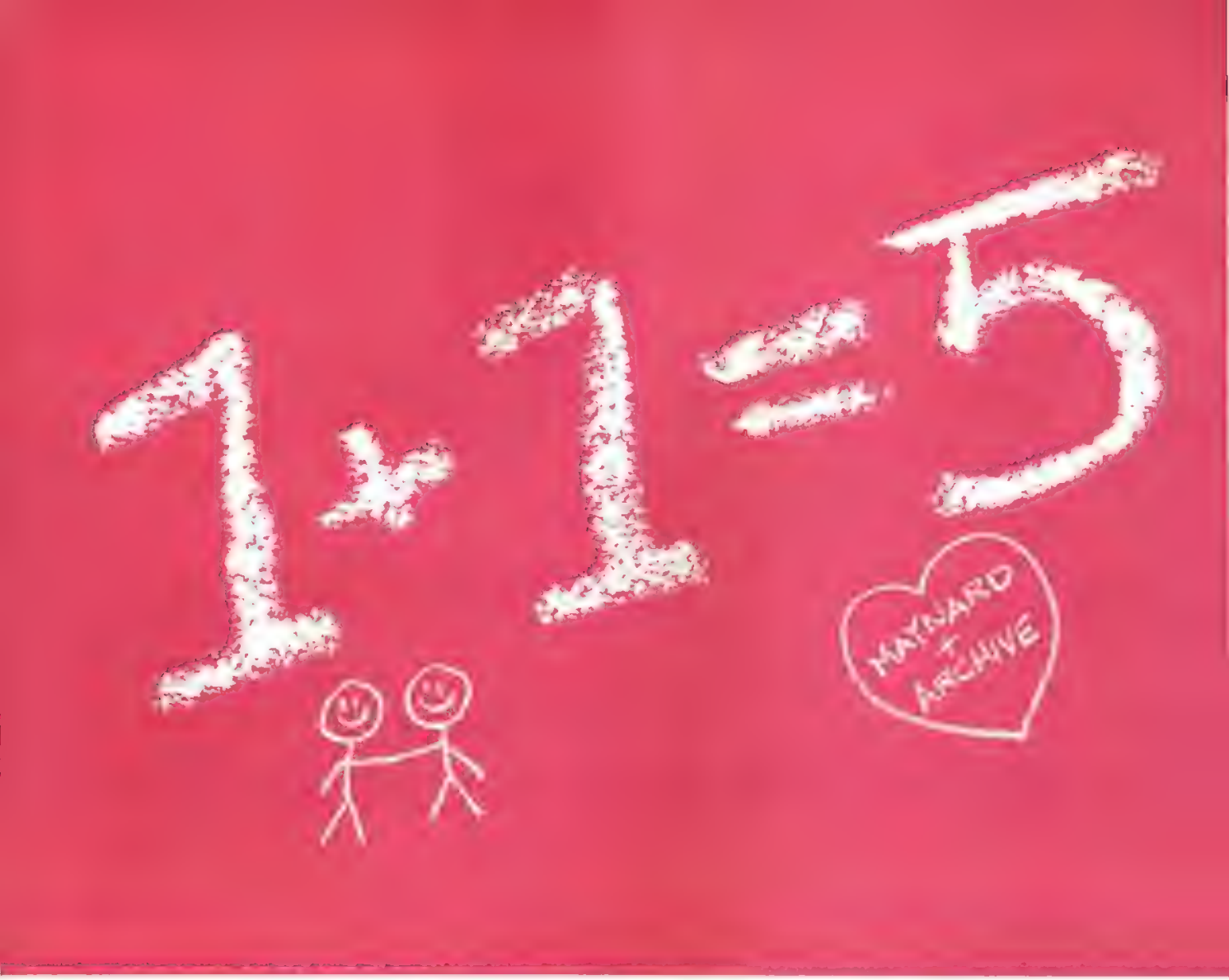
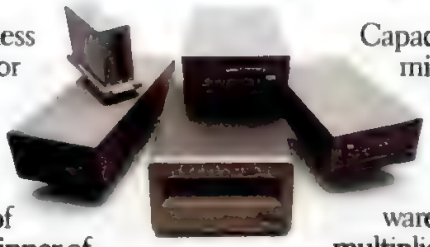


Maynard plus Archive is the answer to tape backup.



Maynard™ and Archive's reseller business has merged to provide a single source for your tape backup solutions. Now Maynard offers five product lines that add up to the most comprehensive array of tape backup systems available:

1. **MaynStream:**™ The first choice of corporate PC and network users and winner of *PC Week's* "Poll of Corporate Satisfaction."
2. **ArchiveVP:**® The performance backup answer for personal computers.
3. **ArchiveXL:**® Our DC2000 line is *PC World's* choice as "Best Tape Backup on a Budget."
4. **FasTape:**® The best value for XENIX™/UNIX® and single-user applications.
5. **MaxStream:**™ Our performance backup solution for the Macintosh.®

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Capacities range from 20 to 2200 MB in cassette, mini-cartridge, cartridge, 4mm DAT, and 8mm formats.

You can count on the quality and performance that have made us the industry leader in tape backup software and hardware. The number of solutions we offer has multiplied, and they all add up to Maynard.

For complete product information call 1-800-237-4929 or write: Maynard Electronics, 460 E. Semoran Blvd., Casselberry, FL 32707.

Maynard Electronics
An Archive Company

We're backing you one-hundred percent.

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by Gus Venditto

Pipeline

A Look at the Trends Shaping the Personal Computer Market

Sharp's New Thin Film Transistor Color Screen Nearing Mass Production

Prototypes of a full-color laptop screen from Sharp are earning passing grades in their final tests, and by this time next year, you'll probably be able to buy a portable with color nearly as good as a VGA CRT monitor.

When this column looked at color laptop research over a year ago (February 14, 1989, issue), Sharp was exploring a double-super-twist LCD panel. That pretty much means they generated color by adding tinted filters to the basic super-twist LCD panel design.

Late last year, NEC introduced the ProSpeed CSX using that technique. The effect is similar to the backlit LCDs that NEC, Toshiba, and Zenith use today with pale color added.

Now Sharp is putting its money on a technique that was being demonstrated last year by Hitachi: thin film transistors (TFT). It's an LCD where each pixel is comprised of three separate transistors, one each for red, green, and blue.

This approach offers the kind of high contrast we've come to expect from cathode-ray tubes but it presents a paralyzing nightmare to assembly line workers. Perfect positioning of all 921,600 pixels is mandatory. Every imperfection shows up as a black hole on the display. Not even the most sophisticated plant can mass-produce LCD panels with that kind of precision and keep costs within reason.

Sharp believes it's solved the problem by doubling the transistor matrix: every pixel has a backup, ready to switch on if the primary transistor fails.

Of course it's an expensive solution, but TFT LCD panels are the best hope yet for improving not just portable displays, but monitors overall.

The early models won't match the precision of a CRT

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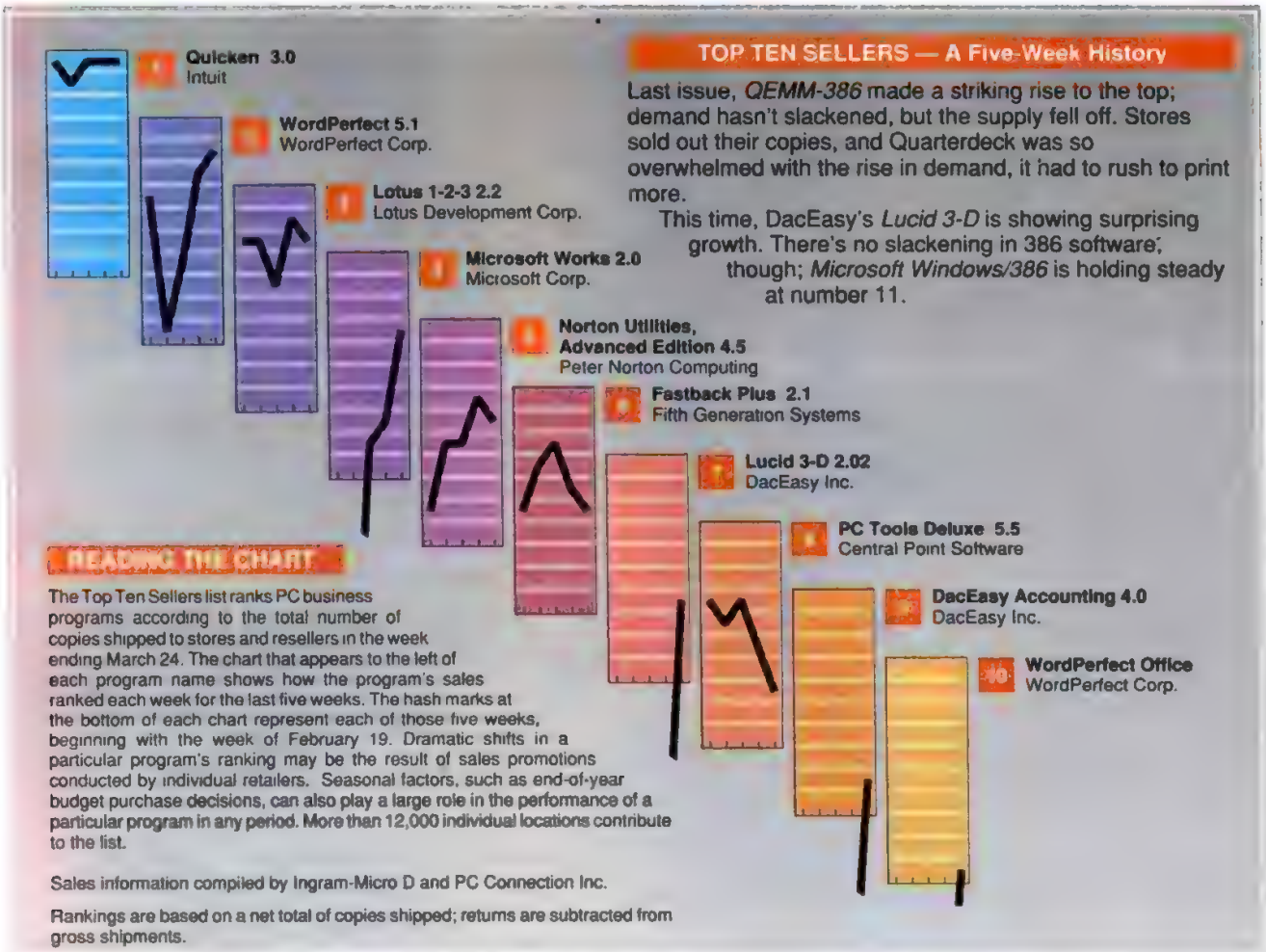


Pipeline

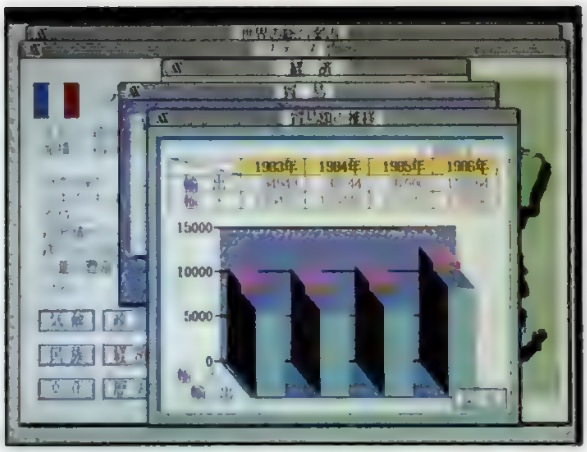
CONTINUED FROM PAGE 63

display, since each TFT LCD picture element has three distinct parts. But as the transistors are refined and miniaturized, a sharp vibrant picture will be possible.

Right now, the largest TFT displays in mass production are 4 inches wide diagonally. After 10-inch displays are perfected, TFT research may yield displays far bigger than today's CRTs.

Sharp says it will make its own color portable and will sell the TFT panels to other computer makers for competitive machines.

And if Sharp's plans stay on schedule, those early color portables will become precursors of a cultural phenomenon even more profound: the flat television set.



Sharp's TFT LCD panel has a VGA-level resolution of 640 by 480 with 512 colors. It should be out of Sharp's Japanese research lab and in mass production early next year.

X.400 Messaging Clears Two More Hurdles

U.S. Sprint has taken the lead in providing the X.400 protocol for exchanging binary files between e-mail networks. SprintMail, which is the new name for the old TeleNet TeleMail service, plans to implement the binary-exchange standard outlined by the National Institute for Standards and Technology (NIST).

The NIST's specification is being used because the official CCITT statement that carved out the X.400 protocol sidestepped the question of binary transfers.

So far, X.400 messaging among public networks like SprintMail, MCI Mail, and AT&T Mail has been limited to text exchanges, although private companies have adopted the standard for use between their own networks. Nearly 500,000 individuals on various public networks are now linked through today's X.400 interconnections.

U.S. Sprint has been talking with other e-mail carriers throughout the binary-exchange testing, so there should be a smooth transition to the NIST standard. In fact, tests between SprintMail and AT&T Mail are already underway.

X.400 links at the text-only level are expected soon for GE's Information Services (GEIS) and IBM's Information Network.

Meanwhile, a joint development venture between Retix and Novell promises to make connections with public networks easier from inside *NetWare* LANs. The two companies are creating a link between the MHS protocols and X.400, smoothing the way for messages that are posted on an office's LAN mail package to be forwarded on to a recipient on an outside network.

A MHS to X.400 gateway for *NetWare 386* is expected to be ready by the summer. Once it's in place, MHS-compatible programs like *Da Vinci eMail* and *Higgins* will be able to reach X.400-equipped e-mail services via Retix's NetWare Loadable Module.

From Bernoulli Boxes to Tape Drives

The highly competitive tape-backup business is getting a new player. Removable-disk pioneer, Iomega, has founded a tape division. The company has no plans to abandon the venerable Bernoulli box; it just sees a need for both forms of storage.

The company's still looking at standards and hasn't yet decided on the range of products it plans to offer. Right now, it's building a staff and sending representatives to standards meetings to help it decide which formats to adopt.

Token-Ring Shortage Nears End

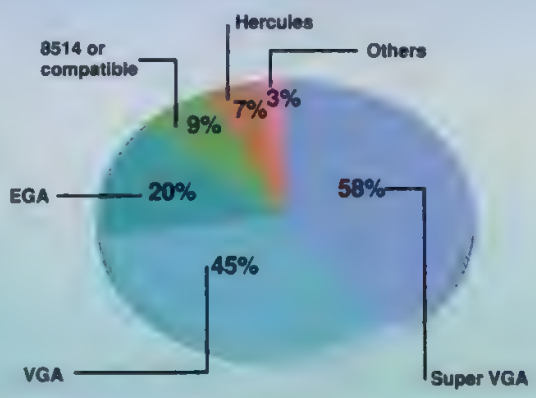
Delays in the development of Texas Instruments' 4 to 16 megabits-per-second Token-Ring chip set have held up network card supplies. TI now believes it has fixed the bugs in the two-part chip set and should be filling the demand by summer.

With this chip set, network cards will be able to switch between 4 and 16 Mbps speeds. ■

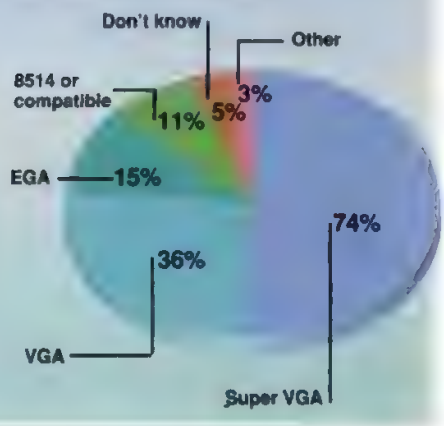
SURVEY

It didn't take long for VGA to become established—and superseded. IBM has ignored video modes above VGA and below 8514, but that hasn't made Super VGA any less popular. Among the 1,126 PC MagNet callers who responded to our survey, the 8514 standard seems likely to gain support in the coming year—but not as much as Super VGA is likely to win.

What type of upgraded video boards did your company purchase for PCs in the last year?



What type of video board upgrade does your company plan to purchase in the next year?



Some foresight into remote computing hindsight.

Hindsight is always 20/20. And it's always too late. Especially if you've spent a lot of money on remote access software with limited features.

Use some foresight. Compare the features of the various packages up front, and the choice will be clear – pcANYWHERE™ III beats the competition hands down. And you'll never have to look back with regret.

But don't just take our word for it. Publication after publication – including the only Editor's Choice for Remote Computing from *PC Magazine* – have cited pcANYWHERE III as the finest remote computing software on the market today. Bar none. It's faster, easier to use and contains features that just can't be found in any other package.

pcANYWHERE III is also the best solution for remote access to a Local Area Network. In fact, Novell chose pcANYWHERE III for remote computing with its new NetWare Access Server.™

And it's less expensive than other leading packages. pcANYWHERE III retails for only $145. Including the necessary software for both sides – host and remote. You can't duplicate this value at twice the price.

So, go ahead. Compare pcANYWHERE III with other remote access software packages. You'll be convinced that pcANYWHERE III is the right choice for all your remote computing needs – today and tomorrow.

Because foresight is always more productive than hindsight, choose pcANYWHERE III for your remote computing needs.

For more information, or to place an order, visit your computer software dealer. Or call DMA at (516) 462-0440, or write to: DMA, 1776 East Jericho Turnpike, Huntington, NY 11743.

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"PC Tools™...powerful eno and simple enoug

Disk Backup

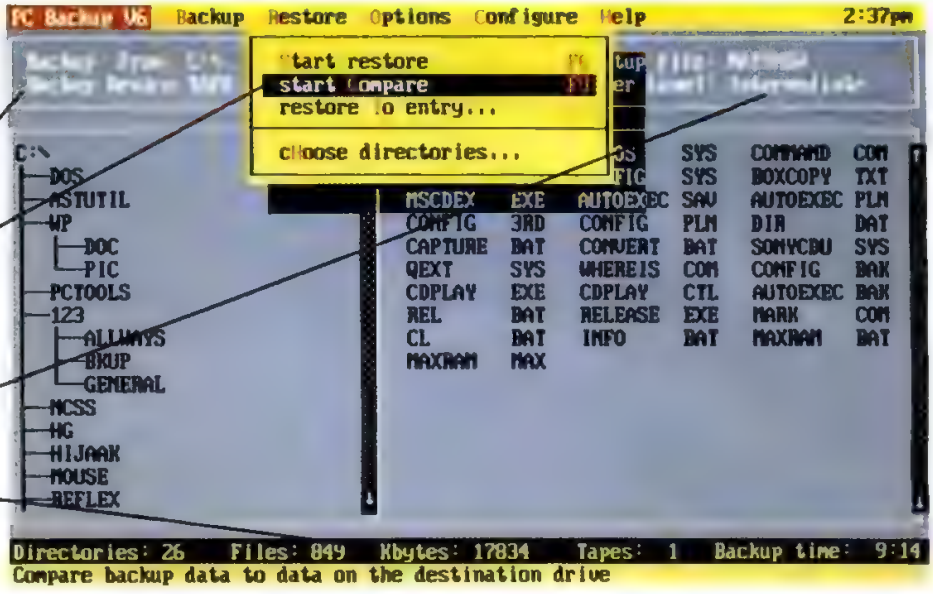
"...a hard disk backup program that rivals any standalone package on the market."
—InfoWorld, May 8, 1989

NEW **Supports tape drives** *used by IBM, Compaq, Irwin, Mountain and others. Features unattended, scheduled backups.*

NEW **Advanced error checking and correction** *make sure your backup is absolutely reliable.*

NEW **With three user levels,** *begin with the basics and add more advanced features when you're ready. (Also included in PC Shell™ below.)*

NEW **Fast and economical.** *Back up at speeds up to 2.5 megabytes per minute. Our new high-speed compression reduces disk/tape usage up to 60%.*



DOS Shell

"...a collection of utilities that you can use from the moment you turn on your computer to the moment you turn it off."
—PC Magazine, Jan. 16, 1990

Network support. *Working with files on Novell and IBM PC LANs is as easy as if they were right inside your PC.*

NEW **Transfer files to your laptop with a** *built-in version of LapLink™ from Traveling Software.*

NEW **Over 30 file viewers** *let you browse through an entire directory of files in a matter of seconds.*

NEW **Resident DOS prompt.** *Hot-key into PC Shell and execute any DOS command without leaving your main program.*

INFO WORLD 1989 PRODUCT OF THE YEAR

The critics agree: PC Tools Deluxe is the most advanced, comprehensive utility you can buy. In fact, Version 5 received about every editorial award imaginable in its class.

This year we're proud to announce PC Tools Version 6: over 70 new features that set new standards for technical excellence

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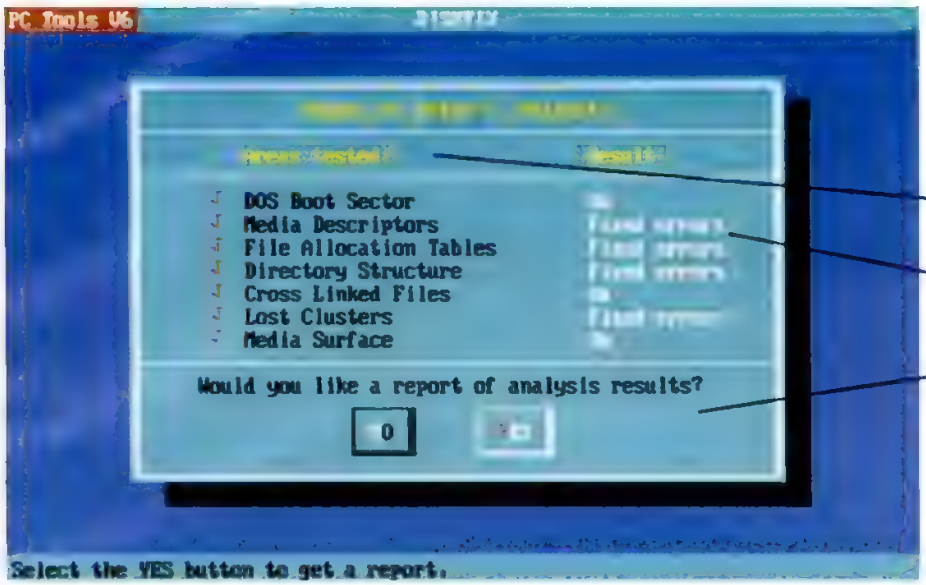
ugh for advanced users h for beginners."

Ed Mendelson, PC Magazine "Best of 1989 Awards," January 16, 1990



Data Recovery

"... a complete system of file protection in one box."
—InfoWorld, Dec. 18, 1989

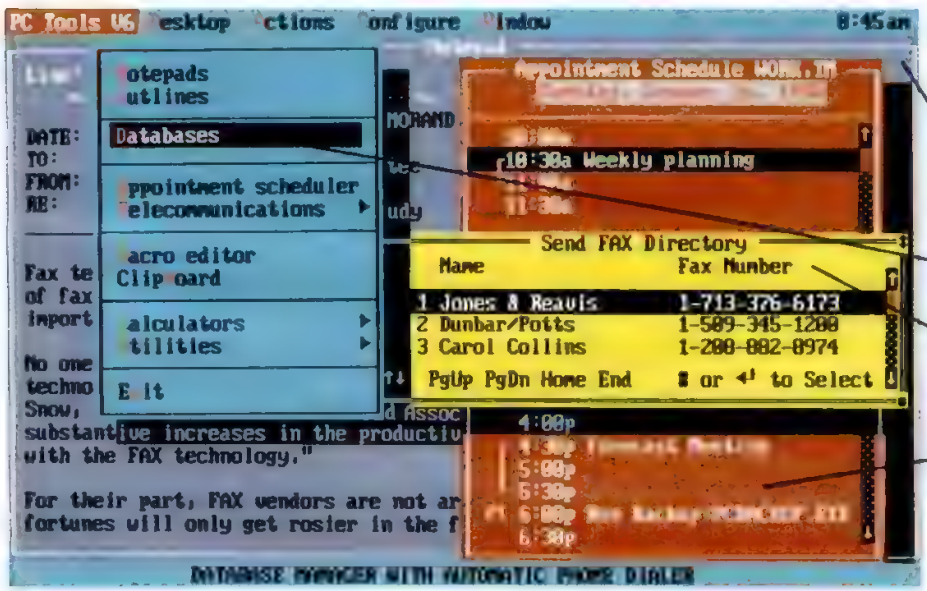
NEW **Powerful and complete.** *DiskFix™ is the most comprehensive disk repair program you can buy.*

NEW **Simple and automatic.** *DiskFix analyzes and repairs disks on its own. It doesn't ask you to become an expert.*

NEW **Fast.** *DiskFix performs over 1,000 tests on a 32 MB partition in as little as six seconds.*

***Undelete and unformat** functions provide fast, easy recovery from deleted files or accidental formats.*

***To speed recovery,** our Mirror program takes regular snapshots of your partition table, FAT and directory.*



Desktop Manager

"... PC Tools shines in the usefulness of its desktop accessories..."
—PC World, Jan. 1990

***Twelve integrated applications,** available on demand. Uses only 40 KB RAM in resident mode.*

NEW ***Our dBASE-compatible database** lets you manage lists, create form letters or autodial calls.*

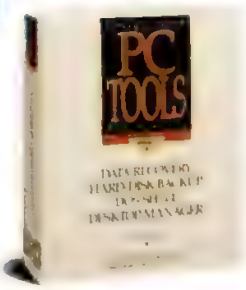
NEW ***Fax support.** With a fax board, you can send an urgent document anywhere in the world. Works over networks.*

***The scheduler** not only tracks appointments, but can do a backup or download e-mail at a predetermined time.*

CIRCLE 749 ON READER SERVICE CARD

and ease of use. For a free, 24-page brochure or information about upgrades, call 1-800-888-8199 weekdays, 7 a.m. to 9 p.m. Pacific time. And get your hands on the world's best-selling utility that just got better.

PC Tools™ Version 6
Central Point Software



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New FoxPro

Classic Beauty. Legendary Power. A Higher Standard in Relational Databases.

Introducing FoxPro. The *only* relational database management system that combines astonishing performance with a sleek interface of amazing power and beauty.

- FoxPro offers all the elegance and accessibility of a graphic-style interface, yet operates at the stunning speeds possible only with character interfaces.
- FoxPro is so easy to learn and use, even beginners can become productive immediately; yet it's powerful and sophisticated enough to satisfy the needs of the most demanding developers and power-users.
- FoxPro gives you choices instead of limits: use a mouse or a keyboard; type commands or use the object-oriented interface; run in one window, or hundreds.
- FoxPro is so efficient, it runs in a 512K PC-XT, yet it's able to take advantage of the speed, expanded memory and extended video modes of the most advanced machines available. You don't even need a graphics card or special windowing software.

Nothing is Faster

Fox Software products are famous for their unmatched execution speed. FoxPro extends that tradition.

FoxPro is up to eight times faster than dBASE IV—more than 15 times faster than dBASE III PLUS!

And that blazing speed translates into unprecedented power. Now you can efficiently process gigantic databases with hundreds of thousands—even *millions*—of records.

Protecting Your Investment

With FoxPro, your existing FoxBASE+ or dBASE III PLUS programs will run perfectly—first time, every time, no excuses. And FoxPro is language-compatible with dBASE IV.

But FoxPro doesn't stop there. It has over 140 language enhancements not found in any version of dBASE. We've outdone ourselves by adding more than 200 language extensions you won't find in FoxBASE+.

Best of all, FoxPro opens up whole new worlds for your applications by letting you move them onto a variety of different platforms.

The Tradition Continues

Fox Software is committed to excellence—our products prove it.

We've been producing superb database management software since 1983. And our products for both the PC and the Macintosh continue to win awards worldwide.

We've taken everything we know about software engineering, databases and interface design, and focused it into one remarkable product—FoxPro.

FREE Demo Disk

But don't just take our word for it. Try FoxPro for yourself, and see what the higher standard of database management can do for you.

Call (419) 874-0162 now to get your free demo disk. Or ask for the FoxPro dealer nearest you. One look, and we think you'll agree: *Nothing Runs Like The Fox.*

FoxBASE+ Users: Call About Our Liberal Upgrade Offer!

System Requirements: *FoxPro operates in 512K RAM (640K recommended) with MS/PC-DOS 2.0 or greater and an 8086/8088, 80286 or 80386 microprocessor. For optimum performance, FoxPro takes complete advantage of any available EMS (expanded memory) or a math coprocessor.*

Trademark/Owner: FoxPro, FoxBASE+/ Fox Software; dBASE III PLUS, dBASE IV/Ashton-Tate.

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CIRCLE 112 ON READER SERVICE CARD

Bill Machrone

Multimedia is more than just presentations. It's destined to revolutionize business communications.

PC Magazine runs on electronic mail. Overall, we think we're pretty sophisticated, whizzing our messages around the office and around the country. We use hard copy postal delivery, e-mail to fax links, and attached binary files.

I've been one of MCI Mail's biggest boosters, proselytizing to just about anyone who would listen. My latest victim was Glynis Gibson, the corporate communications director of Chicago's hot new laptop start-up, Airis. I gave her the full demo, including my boast that most of the key communications in our organization happen via e-mail. I could tell she wanted to be positive about her reaction, but truth won out.

She asked, "Isn't that a little cold?"

I disagreed. I called up an exchange of messages showing wit and humor, protesting that the medium is as warm and friendly as you care to make it.

She was right, of course. It is a little cold.

The problem is with the medium, not the messages. I'm not about to give up electronic mail. Indeed, I couldn't. But Gibson's simple, penetrating question crystallized all that is wrong with electronic mail.

Fellow columnist John C. Dvorak wrote an essay a few issues back decrying the surge in voice mail as a character flaw in American business. He provoked a landslide of dissent. Most of the dissenters cited the richness and completeness of voice mail messages, saying that they were far more effective than the paper scraps with indecipherable phone numbers and little checked boxes.

I agree with our readers. After all, which is warmer—a voice message replete with detail or a little pink form?

MULTIMEDIA MADNESS

Visionaries are proclaiming a bold new technology and a bold new market: multimedia presentations. They're citing the $40 billion spent each year by businesses on training. They're calling for an end to the sequential straitjacket of slide presentations and the eye-busting gray-on-glare of overhead projectors. Beg pardon, but they're not seeing the woods through the trees. I'm sure that presentation graphics is an enormous market and all, and that personal computers will doubtless redefine it. But what we really need is multimedia e-mail. Today, I think it's terrific that I can append a scanned image of my signature to fax messages that I generate with my PC. But what I really need is to effect the full range of business communications electronically: voice, image, programs, animated sequences, distributed databases, and more that I'm probably too limited to imagine. Let's give it a name: Multi-Mail? MediaMail? What's your pleasure?

Let's say I'm on the road. Someone gives me a document that I want my assistant to act on, a sheet describing a new product that I'd like to know more about. I'd like to scan it into my portable computer and have it become part of our database of information. So I'd want it to be retrievable by the usual product categories, manufacturer names, and classifications. But I want to highlight this particular product description and ask my assistant to research similar products for me. So I'd like to take my

ILLUSTRATION: LISA HANEY

pointing device and highlight an area on the document while saying, "See what else you can find with the same general capabilities, and check with the vendors to see if we can get samples into PC Labs by the end of next week."

That's pretty simple. Then I'd want that compound document (facsimile, highlighting, voice annotation, and animating elements) to show up in my assistant's inbox for action. He could replay my thought sequences and come

LOAD RAM-RESIDENT PROGRAMS INTO EXPANDED MEMORY.

AVOID RAM CRAM FOREVER

Introducing New PopDropPLUS.

Shatter The 640K Barrier—Load Up To 50 Of Your RAM-Resident Programs Into Expanded Memory And Execute Them From There!

New PopDropPLUS crushes the memory restrictions of DOS—freeing up your conventional 640K, so it can be used to load today's larger applications.

Your RAM-resident programs are out of the way—in Expanded memory—and available for use with hot-key commands!

PopDropPLUS requires a mere 27K to produce megabytes of "Fat RAM."

And PopDropPLUS will load a RAM-resident program into Expanded memory—*even if it wasn't designed to support Expanded Memory!*

Not Just Another Slow, Inefficient "Swapping" Utility...

Other so-called memory managers wastefully consume 50K or more for their code plus a swap area equal in size to your largest RAM-resident program.

PopDropPLUS however, employs a far more enlightened approach. By manipulating EMS hardware registers, rather than moving programs in and out of memory, PopDropPLUS delivers fast, efficient operation—*using just 27K.*

Load Up To 50 RAM-Resident Programs Into Expanded Memory.

This ingenious breakthrough in memory management allows you maximum flexiblity in managing your memory—without interfering with the applications you have loaded and running in conventional memory.

System Requirements *IBM PC, XT, AT, PS/2 compatibles Requires just 27K. Requires LIM 4.0 expanded memory hardware.*

See your dealer or call (800) 888-2562

No Other Product Available Can Match PopDropPLUS!

PopDropPLUS is a masterpiece of efficiency and productivity. Now, larger applications won't prohibit the use of your favorite RAM-resident programs.

From a pop-up display you can view the list of RAM-resident programs loaded and complete memory statistics. Change your current list of 50 programs loaded—or load another set of 50—in seconds!

Your Memory Problems Are Solved For Just $99.95...

PopDropPLUS will also allow you to remove and replace RAM-Resident programs within conventional memory—*without rebooting your system!*

Includes—FREE! LIM 4.0 Drivers From Intel!

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up with some of his own. From there, the facsimile document would be filed in our database, and he could act on his copy. He could even do a retrieval from the database and send facsimiles back to me that I could view on my screen. In a voice attachment, he could tell me of his progress.

I'd also like to be able to use my laptop as a portable answering machine. Today, it can check my e-mail for me from my hotel room while I'm out visiting companies or having dinner. But what if I were expecting several calls from some people with information for me? They'd be far more likely to leave a message on my personal answering machine, having been greeted by my voice, than with the hotel operator. Even if they're not e-mail customers, we could still communicate. They could use their own phone numbers as personal keys to retrieve any messages I might have left for them. Some voice mail systems can do this today. But imagine the convenience of always having your voice mail system with you. For that matter, let's make it an extension of your office voice mail system so that your computer calls the PBX, gets your messages, and holds them for you.

DUELING KEYBOARDS

Think of how much more effective this kind of communication would be rather than merely typing at one another, which is what we state-of-the-art practitioners do when we're not busy playing telephone tag. Some of this is actually happening at NeXT Computer Corp., where employees use the advanced user interface, sound capabilities, and object orientation to craft rich, effective communications to one another.

Right now, we're on the eve of the dominance of the graphical user interface (GUI). Character-mode machismo, however, runs rampant.

To overcome it, we need a few enabling technologies: faster dial-up communications, flat color displays, advanced scanning technologies and optical systems, far denser storage, digital signal processing, and faster processors. Oh, and the software to knit it all together and make it work.

Multimedia itself is not an enabling technology. It's a humanizing technology. We're getting a little warmer. ■

DacEasy Accounting
There's New Strength in Our Numbers

$149.95

Just Announced!
March 5, 1990

The World's Bestselling Accounting Software Now Comes With a Choice.

Since its introduction in 1985, more businesses have chosen DacEasy than any other accounting software. Now with the introduction of Version 4.1, our newest member of the family, you have the perfect accounting choice for the 90's. For those of you with older or less powerful computers, we continue to offer Version 3.1, the only full-featured, award-winning accounting program ideal for your environment.

Both Version 4.1 and Version 3.1 offer fast and easy installation that takes just minutes, plus feature-rich, powerful performance. These are a few of the many reasons why more than 1/2 million businesses have computerized the DacEasy way.

Version 4.1, The Best Accounting Choice for the 90's.

Version 4.1 has already acquired two major awards since its introduction last Fall. Version 4.1 features NINE fully integrated modules: ***General Ledger, Accounts Receivable, Accounts Payable, Purchase Order, Inventory, Product Assembly, Graphics, Report Generator*** and ***Cash Management.*** Unlike Version 3.1, Version 4.1 requires 640K memory and a hard disk. We also recommend (not required) a 286 processor for faster performance.

New time-saving features found only in 4.1 include ***automatic look-ups, optional mouse support, cash management, reconciliation, custom report generator, graphics, budgeting, multiple open periods, sales analysis, product assembly, monthly detail, import/export capabilities*** and ***much more.***

Version 4.1 has been the fastest selling accounting package in our history. The value is tremendous, especially, when your business is ready to grow into a network capacity. Version 4.1 transfers your files effortlessly to the DacEasy Accounting Network System.

Includes Both 3 1/2" & 5 1/4" Diskettes

DacEasy – The Most Award-Winning Accounting Program Ever.

Version 4.1 was recently voted the Accounting Product of the Year by the readers of *InfoWorld* magazine. We have won an unprecedented four straight *PC World* World Class Awards voted by its readers. The awards selected by the users are our most treasured. Naturally, we love the Editors' Choice awards, too, and have won more than any other accounting software publisher.

Both our accounting versions are backed by a great supporting cast. DacEasy Payroll stands alone or integrates with DacEasy Accounting 4.1. Both are supported by videos, self-paced tutorials, nationwide seminars and our new DacEasy Advantage Club support program.

We also offer Accounting, Payroll and Video Tutorials in the DacEasy BonusPack for only $299.95 retail. And these programs are easily upgradeable to the new DacEasy Network Accounting System ($499.95 retail) at special upgrade prices.

DacEasy Accounting, Version 3.1. The Choice for Today's Less Powerful Computer.

Version 3.1 is the only full-featured accounting program that can run on a dual floppy system and it takes little room on a hard disk. It only requires 256K of RAM, yet is power packed to get the job done. Ideal for service or inventory based businesses, Version 3.1 features SEVEN integrated modules: ***General Ledger, Accounts Receivable, Accounts Payable, Inventory, Purchase Order, Billing*** and ***Forecasting.*** Plus, we've included DacEasy Graph+Mate ($99.95 value) for **FREE.**

DacEasy,™ Inc.

17950 Preston Road
Suite 800
Dallas, Texas 75252

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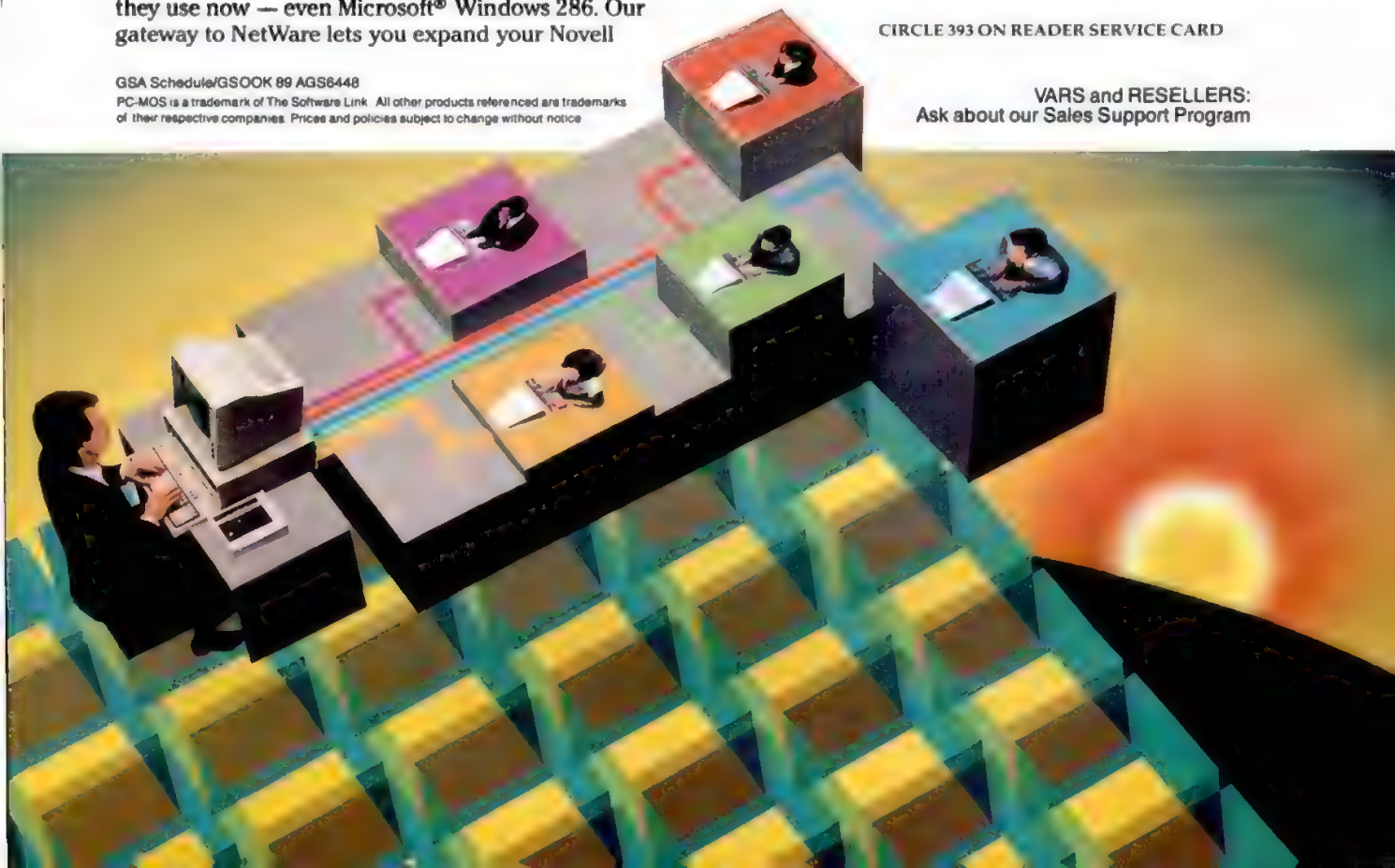

John C. Dvorak

Initial software support guarantees a product's success, right? Wrong.

I have finally figured out the formula for success in the computer market, and it's not what you'd expect. To understand it, you must first understand that the need for initial software support is a myth.

Many projects that had tons of initial software support have failed, while others with no support have succeeded. Take the Texas Instruments 99/4. It was loaded with software ready to ship. So was the Adam, the lingering Amiga, the DEC Rainbow, the Polo, the Mindset, the ill-fated DOT, and a host of other machines. The TI 99/4 had graphics that would blow away anything. Moreover, it had the support of Texas Instruments. Heck, even Bill Cosby went on the road for the thing, saying that any other machine (such as the floppy disk-based Apple II) wasn't as good because "it doesn't have as many cartridges!"

But when the TI 99/4 first hit the streets, it was apparent that it was a dog. It had no room for expansion and no disk drives—but it did have a stupid keyboard with a key or two missing. It was a glorified game machine that hardly outperformed the Apple II that it was designed to destroy.

Worse, its orientation toward cartridges rather than floppy disks negated the advantages floppy disk owners had if they wanted to go to a user's group to download public domain programs or contribute programs of their own design. But TI could sucker software vendors into producing cartridges for the machine, since there was no way the cartridges could be easily bootlegged.

The idea of appealing to the software vendor rather than to the eventual buyer of the machine fascinates me. Many vendors are convinced that the key to their success lies in a conundrum: people buy computers that they believe have the most available software; but software only becomes available when the machine matures. They're just fooling themselves.

Examples abound. The PC itself had virtually no software when it arrived on the scene. All that appeared were a few demo programs, the operating system, BASIC, and a mediocre word processor. The Macintosh also arrived with nothing but a word processor, an operating system, and a paint program.

The PC didn't even have as much as the Mac, yet it somehow captured the imagination of users (and independent developers). When a card called Baby Blue became available, its success was assured. With a bare-bones Z-80 microprocessor, the Baby Blue was essentially a small 64K CP/M computer. Beyond that, it was the transitional link between the old world and the new—a *sine qua non* for the easy success of any "next generation" computer utilizing a new architecture.

Just as important, MS-DOS had essentially the same interface as CP/M, so CP/M users had no harsh learning curve to climb when they moved from one system to the other. This is also critical. (For the Mac—a special case—Apple didn't take a transitional step from the dreadful Apple II interface. Instead, the Mac adopted an interface a four-year-old could learn in minutes.)

The next PC transition will require the same formula as before: an add-in card that provides PC compatibility for a short term, and a user interface resembling MS-DOS. A

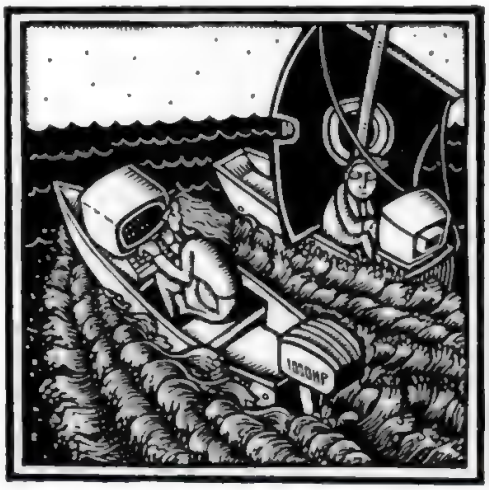

ILLUSTRATION: LISE HINNEY

simple, new Baby Blue-like card would only need a half-dozen or so chips. It would cost less than $200 and run most PC applications, thanks to the fact that the applications never got beyond 8088 code. The user interface resembling MS-DOS looks to me like OS/2.

So, all we need is a platform that the core influencers all agree on and we're off to the races. How important is initial massive software support? It's not.

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John C.
Dvorak

Inside Track

While everyone worries about the next **hot** processor chip, a small team of engineers at Intel invented the 80170, the world's **fastest and most powerful** neural network on a chip. In processing power, it is something of a breakthrough, having achieved the theoretical intelligence level of a **cockroach**—no kidding. While this invites images of the chip sneaking into the kitchen for a snack, the neural network community is **giddy** over this chip and its potential. I visited with the chip's developers, who admit that this analog computer possesses a **frightening** amount of processing power and has the company baffled. "Nobody at Intel knows what to make of this thing," I was told.

Intel's 80170 chip has the theoretical intelligence of a cockroach—no kidding.

Intel will be announcing development systems using this chip in the weeks ahead. The first Intel-approved software to front-end the 80170 will come from Mark Lawrence and **California Scientific Software** (the company is relocating to Grass Valley, California, and can be contacted by calling (800) 284-8112). Lawrence, considered a genius by many in the community, has finally upgraded his all-software **neural network** simulator packages, so creating a neural network is now easier. The original *Brainmaker* had a **mediocre** interface, as powerful as it was for the money. Well, the company has **hot new** versions, including an elaborate professional development system. *Brainmaker* is $199 (with enhancements and improved ease of use); *Brainmaker Professional* is $795 and has all sorts of bells and whistles. Each includes a book introducing neural nets. You don't need the Intel chip to use this stuff; any PC will do.

Neural nets aren't programmed—they're **trained—like a dog.** The programmer's job (if one can be called a programmer) is to organize the data in such a way that it can be analyzed over and over until the network discovers patterns and extrapolates data from incomplete data sets. **Predicting weather** and determining which horse will win the third at Belmont are perfect neural net applications.

There's a *Who's Who* of famous scientists actively interested in exploiting neural nets. Don't be left out. There's something **big** lurking beneath the surface of this technology.

CD-ROM Conference Dept.: If you didn't notice, yet another CD-ROM conference has come and gone. It gets **more boring** each year. I keep looking at CD-ROM systems and still find that few of them work on high-performance PCs. Now word has it that the prices of the drives are dropping, but there is no compelling reason to buy one. The vendors of interesting databases charge far **too much** for disks, hoping to **milk** the life out of their hardcover book business. The *Encyclopedia Britannica* people are perfect examples. They will stick with their **moribund** technique of sending out door-to-door salesmen in hopes of selling a few thousand expensive sets of books that become outdated so fast it makes your head spin. They do this rather than **blow open** the CD-ROM business with an inexpensive disk set that would cost nothing to manufacture. Millions could be sold with new quarterly updates. It's inevitable that someone will do this, but only Grolier shows any signs of understanding the principle.

Britannica, instead, bought *Compton's MultiMedia Encyclopedia* and put it on a CD-ROM. You get the feeling that the corporate powers (ex-door-to-door salesmen, no doubt) **hope that this experiment will flop** and are doing what they can to assure its failure. For example, they are so **squeamish** about the *Compton* product that they are reluctant to pass out review copies. A reviewer can only get a "loaner" (of a disk that costs $2 to manufacture) for a couple of months.

Let's face it: if CD-ROM is going to happen, the action won't emanate from the publishers of **archaic hardcover monstrosities** that need to be pushed by high-pressure salesmen. A set of expensive hardbound encyclopedias is largely sold as ornamentation to the **guilt-ridden** TV-watching lower- or middle-class family and represents a **dubious badge of literacy.** Heaven forbid this **pathetic** and outdated ego-driven need to show off a wall of never-read encyclopedias be supplanted by the useful CD-ROM version of the books, eh? All this backward thinking irks me.

Genuinely Interesting Gizmo Dept.: It's not cheap at $199, but The Switch Model A-3 from High Tech Resources (230 Main St., P.O. Box 1400, Ellsworth, ME 04605; (207) 667-6300) is a **phenomenal three-port FAX/phone/modem switch,** maybe the best. It branches one phone line into three. Furthermore, the A-3 takes advantage of the new custom-calling service from the phone companies called "distinctive ringing." This is a service by which the phone company can assign several different numbers to a residence or business without physically installing separate wiring. This is an **important** service in rural areas where stringing more wires is **prohibitively expensive.** Distinctive ringing patterns are assigned instead for each "virtual" line, so that the person in the residence or business can identify the incoming ring.

The A-3 detects the ring tone associated with a FAX line and switches output accordingly. It also has a timing pattern to detect CNG tones generated by auto-dial FAXes. Access is switched to the modem port through a variety of means, including a **program written by Crosstalk** to automate certain host functions. No other switch I know of has this feature. This is a good way to get the most from one phone line. ■

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CIRCLE 129 ON READER SERVICE CARD

Jim Seymour

Those who started the PC revolution are finding themselves outflanked by major vendors, who now want to sell directly to the biggest customers.

A few months ago, *PC Magazine*'s columnists offered their thoughts on the future of computer retailing in the 1990s. Our view, overall, was not very bright. And my vision was especially dour: traditional, near-list-price computer retailers as we've known them are going to be rare birds.

A principle cause of that diminished future for PC retailers is becoming apparent, as major software and hardware vendors begin to focus on direct sales to their largest accounts. Far from being an aberration, this phenomenon is becoming the norm and it is one of the fundamental changes this business is going through as we enter the 1990s.

Selling direct? That, of course, is exactly what many of those same vendors said would never happen. They'd rely on the distributor/retailer channel forever, they said.

But as alternate channels of distribution came into being in the eighties—principally, large mail-order discounters of name-brand goods—some of those promises began to ring hollow, as the biggest PC vendors' names appeared prominently in the discounters' ads.

Oh well, maybe our products *can* be found in a few of those places, spake the vendors. But you can be sure that one thing we'll never *ever* do is sell directly.

Uh-huh.

Today almost every major PC-industry company—no matter what you may be told to the contrary—sells directly to some of its customers. Many earn a very significant part of their annual revenues through those sales. And virtually all are now looking at how they can capture their largest customers—typically, Fortune 1000 companies—as full-time direct customers.

In the process, of course, they're pouring gasoline on their already smoldering relationships with "the channel."

Indeed, "channel conflict" is now so commonplace and so widely accepted as part of doing business that the sanctimonious words of years past from vendors about the need to reduce channel conflict are rarely heard. "Reduce it, hell," seems to be today's motto: full speed ahead and damn the retailers!

You'll never hear words like that in public from any of the self-anointed statesmen of this industry. But you can bet that's the mood in their strategic planning sessions.

There are three good reasons for makers of any kind of product to sell directly: control, complexity, and margins. All three reasons weigh heavily in most PC companies' recent decisions to focus on direct sales.

ACCOUNT CONTROL

Control of those big accounts is the long-term play. In pitching to corporations, Microsoft, for example, badly wants to be seen as their primary PC software supplier. With such leading products as *Word*, *Excel*, *Project* (the forthcoming database product), and, of course, *Windows*, DOS, and OS/2, the company says, you don't *need* anyone else.

And boy, will Bill Gates and company make it worth your while to go Microsoft across the board—not just by offering low prices but also by providing help with training and support.

ILLUSTRATION: LISA HANEY

Indeed, Microsoft is recruiting furiously now, mainly out of its New York City office, for big-account reps.

Microsoft is far from alone in this "preferred-supplier" strategy, of course. IBM's National Accounts Division has long skimmed the largest PC accounts for itself. Lotus, too, is eager to gain control of its large accounts. And so on down the list.

The big mail-order firms are playing the

game as well. In fact, they taught the rest of the industry how valuable direct relationships can be. While their products, by and large, were never in the retail channel, companies such as Dell have shown how profitable it can be to build a direct relationship with large customers.

It's not only the sales volume that counts, of course; it's the inside information that flows between a customer and a primary supplier of essential goods. By being the first to hear what customers say they'll be buying over the next few years, vendors who have cozied up to big customers have an enormous advantage in developing and pricing new products that fit those specs, which in turn helps them control the account even better.

MORE-COMPLEX PRODUCTS

Complexity is another force driving this move to direct sales. As PC products have gotten more complex—harder to install, learn, and use, and especially, harder to get working with critical connectivity links—vendors find themselves frustrated by the retailers' marginal sales staffs and even poorer tech-support groups.

For many of today's most important, leading-edge products—and increasingly, among the kinds of PC products that will dominate the market in the 1990s—the long and complicated selling cycle and the complex process of putting the products to use, once purchased, are beyond the resources of both retailers and many VARs.

So vendors have begun fielding direct-sales forces, schooled in the ways of selling big-ticket products to big-name companies. Very often, after-sale support for installation and training is included in the sale.

Lotus's *Notes* is a good example. At $62,500 for a 200-machine license, *Notes* carries a price tag far beyond what we're used to seeing in the PC business. (In fact, the per-user cost is only about $300, putting *Notes* right in the middle of what most businesses pay today for spreadsheets, word processors, and databases.) Lotus includes in that price not only installation assistance at buyers' sites but also help in developing their first *Notes* applications.

But Lotus is only selling *Notes* directly. It knows this is a "missionary sell" and that a Lotus-managed sales-SWAT team is going to do a far better job of persuading large companies to commit to *Notes*. After all, isn't that first 200 desktops in a company what Lotus is really after: it wants more of the 5,000- and 10,000-unit sales it's already scored with *Notes* at companies like Price Waterhouse and Manny Hanny.

I think it's clear that the emerging class of super-servers is going to demand that kind of treatment, too. We will see, I'm convinced, the last and loudest of the big no-direct-sales vendors abandon a strategy that worked a lot better in the 1980s than it will in the 1990s.

Compaq built its business on strong dealers. By raiding master salesman Sparky Sparks away from IBM, then putting him on the road to develop a dealer network stronger and tighter than IBM's own, Compaq built the foundation for its success.

Compaq has supported those dealers with an unwavering policy of "all sales go through our dealers." Though Compaq certainly fields a large group of reps who call on corporate accounts, sales generated by those calls are funneled through dealers.

THE SYSTEMPRO CHALLENGE

Compaq's Systempro, the most complex new PC hardware product in years, is going to be a severe test of that commitment. The complexity of installing networks based on Systempros is beyond almost all of Compaq's dealers.

The company is trying to support those dealers by running training classes focusing both on how to sell the Systempro and on how to get it up and running. But I'm convinced that in the end, complexity will force Compaq to divide its products into two classes: those sold by dealers and those sold directly by the company to large end-user accounts.

And once *that* system is in place, Compaq will soon discover that for reasons of account-control and better margins, its sales reps must be able to deliver the whole Compaq line, not just the high-end systems.

Better margins is the final compelling reason, the key in the lock, for PC vendors to sell directly to their largest accounts.

When sales are scattered widely, and vendors have little idea who their customers are and how their products are being used, the traditional manufacturer/distributor/retailer chain makes a lot of sense. As long as their products are reasonably in sync with market demands, vendors can essentially toss them into the system and watch sales grow.

But as markets mature, companies begin to see a clustering of their products in the hands of a relatively small number of customers. With little effort, they can identify those major customers; to keep the sales flowing, they begin calling on them from time to time, in an advisory way. No selling, of course, just looking for feedback and making sure the customers know they're cared about and are being heard.

But when you've created that network of well-identified, well-understood customers who get regular calls from your reps, you begin to wonder why you're giving up so much money to those "missing links" in the channel—distributors and retailers. What, exactly, are *they* contributing to making the sale?

THE HIDDEN NUMBERS

Let's look at some numbers you never see in print: typical distributor discounts from retail price. These days, software publishers give up at least 60 percent of the retail price of their packages to their distributors. Many give up 63 percent or 65 percent. And with one of the largest word-processing software vendors giving its distributors a *70 percent* discount off retail, the pressure on other software houses to take the 60 to 65 percent break and be damned glad about it is very strong.

Seventy percent? That means you get only $150 for a $500 package. Even if that package finally sells on the street for only $300, you're giving up $150 per unit. Ouch!

(In hardware, the margins aren't quite so wide, but they're close. And considering that most big-ticket hardware passes directly from manufacturer to retailer, they're generous indeed.)

So the successful vendors in the PC market have every incentive to bypass what they consider a wasteful, expensive, and often inept distribution channel by selling directly.

Sure, it costs money to field a sales force, book orders, and ship boxes. But when you focus on large-volume accounts—and when you have a rep sitting in those customers' offices every few weeks anyway—direct selling costs only a tiny fraction of what you're paying now for a distribution system that does little, if anything, to foster those large-customer sales.

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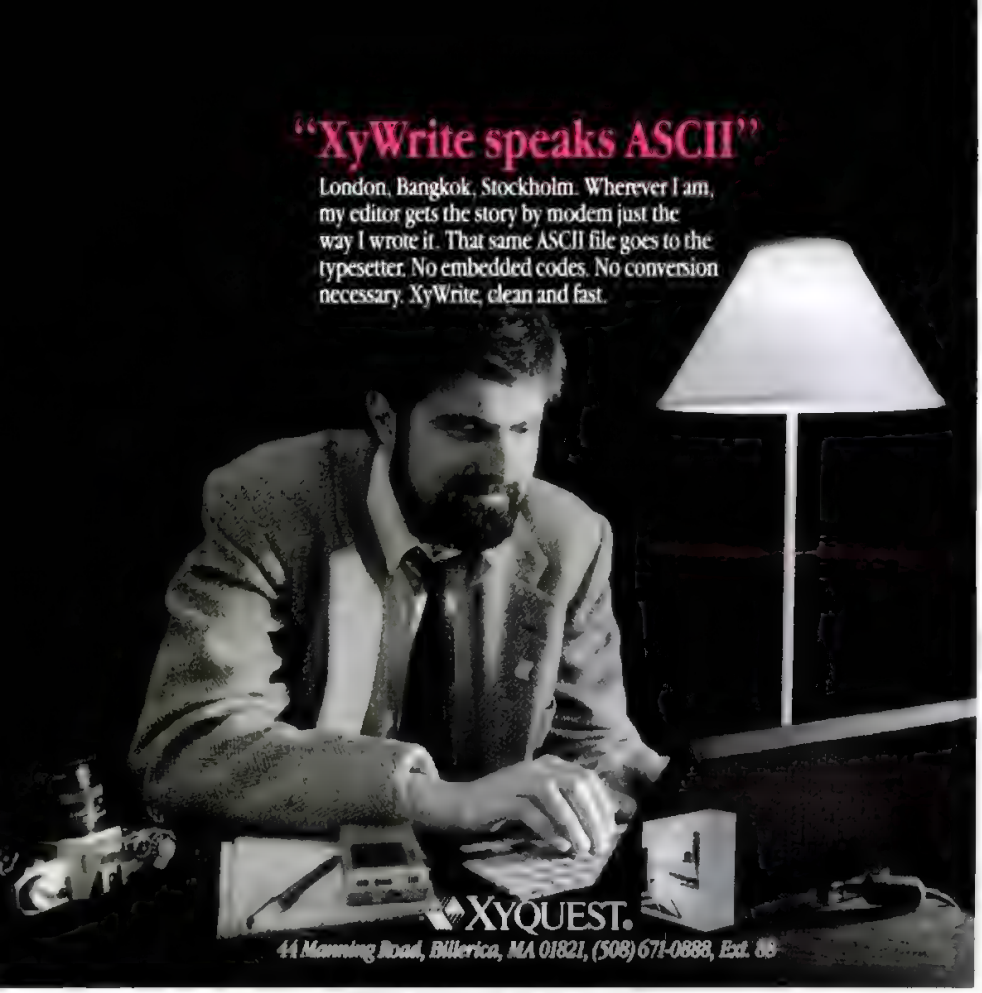
CIRCLE 212 ON READER SERVICE CARD



CIRCLE 518 ON READER SERVICE CARD

Computers, FCC Class A, Class B, and You — or When is it better to get a B than an A?

You need to know the difference between computers that meet the FCC class B radio frequency emissions standards and those that meet only the Class A standards.

Computers emit radio signals in their operation. Because these signals may cause interference to radio and television reception, the marketing and the use of computers is regulated by the Federal Communications Commission. Under federal rules, computer users are responsible for remedying interference, including interference in neighboring homes.

Computers certified by the FCC as meeting the Class B standard are less likely to cause interference to radio and TV reception than those that have been verified by the manufacturer or importer to the Class A standards. Only Class B certified computers may be advertised, sold, or leased for use in residences. A similar regulatory program applies in Canada.

Buyers seeking computers for use in homes (including offices at home) should shop for computers and peripherals which have been Class B certified. These devices carry a label with an FCC ID number. Both new and used Class A verified devices may be sold only for use in commercial and industrial locations. Signals from computers are more likely to be masked by electrical noise from other equipment in such an environment. These areas are also likely to have fewer radios and TVs. Accordingly, equipment marketed only for use in these locations may meet the less rigorous Class A standard. Class B certified equipment may be marketed for use in residences as well as commercial and industrial locations.

As you shop for a computer for use in your home, look for the FCC classification in the specifications or ask your vendor to recommend only machines that have been certified to the Class B limits. TV viewers and radio listeners in your home and in neighboring homes will be glad you did.

Jim Seymour

Instead of booking $150 per $500-list package, for example, you can sell to major accounts for 10 percent less than the lowest street price—and still keep almost twice as much as you earned from that box before.

Distributors and retailers have lots of good arguments about why this is a lousy strategy for major vendors, and for those major accounts, too. They talk about products that became successful only because the channel gave them visibility. About customers who rely on retailers and VARs. About fairness in the marketplace.

It sounds good. But when all this is stacked up against the account control, the ability to sell more-complex products, and the greater margins that result from selling directly, few PC vendors find those arguments relevant, let alone persuasive.

Over the next couple of years, watch for a huge shift in PC hardware and software sales. Vendors will increasingly be skimming the cream off the top by keeping richly rewarding big-account sales for themselves while trying to keep their products trickling through the remnants of the once-dominant "channel."

THE BUYER'S REWARD

For corporate PC buyers, the move to more direct selling is probably a good thing. A closer relationship with the people ultimately responsible for making things work will be an advantage. And if they exploit multiple-product purchase offers and other quantity-discount deals that vendors will be offering, the cost of buying new technology may drop slightly.

For smaller businesses and individuals, there should be few important advantages or disadvantages. Retailers will be less prosperous, which means the generally low level of expertise and support found today in the retail channel is not likely to get any better. Prices are likely to drift slightly higher, as retailers increase margins to offset the loss of those big, profitable corporate sales.

In the end, the only real loser in this upheaval will be the retailer—that fellow who nurtured and sustained this business in its early days, supported many of today's most successful products when they were foundering upstarts, and spread the gospel of the PC revolution.

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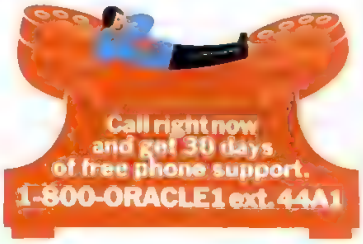

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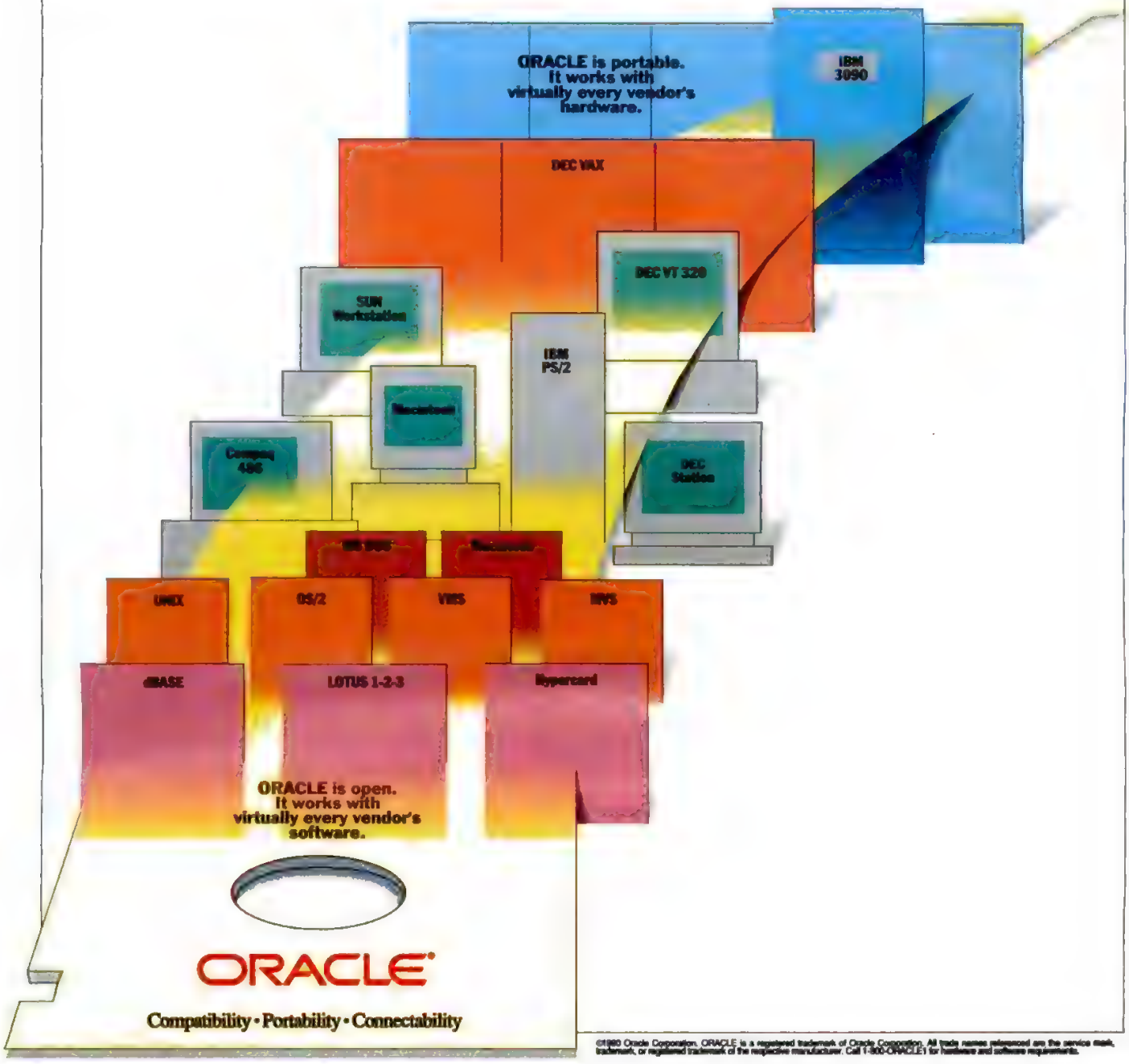

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William F. Zachmann

By adhering to policies that further their own interests at the expense of OS/2, IBM and Microsoft have left the door wide open for Unix.

For OS/2 to fulfill its destiny as heir to DOS, Microsoft and IBM are going to have to get their act together soon. It's now more than three years since OS/2 was introduced. It's time the promises for OS/2 were kept.

It remains my view that OS/2 will be successful as DOS's successor. However, delays in removing the obstacles that stand in OS/2's way are already opening the door for a competitive alternative—Unix. The longer Microsoft and IBM take, the better the chances are that Unix, rather than OS/2, will capture the office desktop market.

What's holding back OS/2's success? Perhaps the most often mentioned problem is that OS/2 was developed for the Intel 80286, a microprocessor that wasn't powerful enough to support the operating system. Hindsight tells us that OS/2's future might have been brighter had it been developed as a 32-bit operating system targeted for the Intel 80386 in the first place.

On the other hand, even in its 286 versions, OS/2 runs well on 386 or 486 systems. So, while OS/2's lack of initial support for the capabilities of the 386 and 486 chips is regrettable, this really isn't as big an issue as it is sometimes made out to be.

Far more deleterious has been that OS/2 wasn't finished. Early versions lacked key basic capabilities. In some cases, those have become available only recently or are still missing. Further, some features in early versions were only partially or imperfectly implemented.

Then, too, there are the issues of hardware independence and Microsoft's policy regarding device drivers. In theory, OS/2 was to be a major advance over DOS in device support. By designing device drivers into OS/2, Microsoft offered the promise of relieving applications from having to directly support a large number of peripherals.

The problem, however, was that Microsoft largely left it up to peripherals manufacturers to develop OS/2 drivers for their products. But since that was a rather complex undertaking, most peripherals vendors were in no hurry to devote resources to the task.

Thus, users are reluctant to use OS/2 until drivers are available for key peripherals, and peripherals vendors, waiting for OS/2 to catch on, haven't been motivated to develop drivers. In the end, the lack of device drivers, rather than harming the peripherals vendors, is inhibiting the acceptance of OS/2.

PRINTERS AND OTHER PROBLEMS

Perhaps the most absurd goof in this regard was in OS/2's inadequate support for HPPCL printers. OS/2 PM drivers weren't available until IBM OS/2, Version 1.2, and even then didn't work with some software, lacked full font support, and were buggy.

The problem extends beyond printer drivers. A wide range of disk controllers, specialized I/O boards, and even memory cards already in use on ISA systems running DOS are still without OS/2 driver support.

A related problem is that the theoretical device independence of OS/2 has in reality proven to amount to "device specificity," a major inconvenience. This is relevant not only to peripherals but to systems.

ILLUSTRATION LISA HANEY

While, in principle, every vendor of IBM compatibles was supposed to license DOS from Microsoft, in practice, most users simply put the most recent IBM version of DOS on compatible systems. That is not readily possible, if it is possible at all, with OS/2.

The hardware specificity of OS/2 has obvious short-term benefits to both IBM and Micro-

soft. It gave IBM the opportunity to encourage buyers to purchase only IBM systems so that they would be sure that IBM versions of OS/2 and OS/2 Extended Edition would run on them. It also gave Microsoft the opportunity to collect more royalties from hardware OEMs.

The problem, however, is that users were already accustomed to what amounted to generic DOS, and want what amounts to generic OS/2. Since a similar kind of catch-22 situation has developed with hardware vendors, the acceptance of OS/2 has been bogged down yet again.

Yet another factor has been the lack of a single clear message regarding OS/2 from IBM and Microsoft. Despite their superficial effort to put forth a convincing common view at Comdex last November, the reality is that both, by their actions, have sent out conflicting signals. IBM's February announcement of the RS/6000 and expanded support for Unix, and Microsoft's handling of *Windows* 3.0 have left doubts in the minds of users about how committed either company is to OS/2.

Indications of disagreement between IBM and Microsoft regarding screen-font strategies and other enhancements have done nothing to dispel the impression that OS/2's developers are not always pulling in the same direction. Nor has the confusion about the differences between OS/2 Standard Edition and OS/2 Extended Edition helped any.

Finally, while there is good reason for Microsoft and IBM to keep on enhancing OS/2, this will continue to make application development for that operating system more difficult. Given the lead times required for major software development on the one hand, and the rate at which OS/2 versions are changing on the other, it has been difficult for developers to recoup their investments in OS/2 software.

Both IBM and Microsoft seem to have such confidence in OS/2's success that they have continued to do things that further their individual short-term interests. But it's time for them to get solidly behind OS/2 in a consistent manner.

SAGE ADVICE

Here's how: IBM should drop OS/2 Extended Edition and offer its capabilities in the form of an add-on application module that would run on a generic OS/2. Microsoft should drop its OEM-only strategy and offer a generic OS/2 that can be tailored with additional modules specific to individual systems as well as various peripheral vendors' hardware.

Both IBM and Microsoft should more actively assist and support the development of device drivers for OS/2, and one or both should take responsibility for developing device drivers for widely used devices rather than passing the problem on to other vendors.

IBM and Microsoft should move as rapidly as possible to create a generic OS/2 that's a stable target for software developers for at least a few years. The timetable for and nature of future enhancements should be made public so that users and independent software vendors know what lies ahead. Otherwise, Unix's prospects for claiming office desktop PCs will start to look better and better. ■

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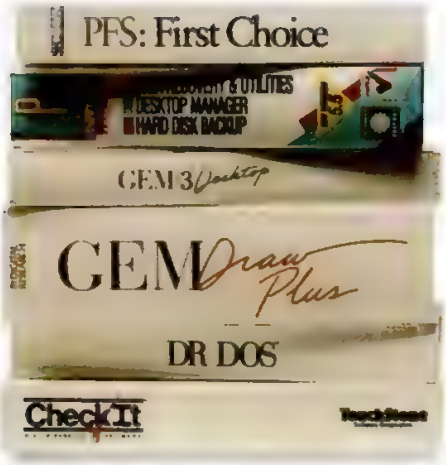

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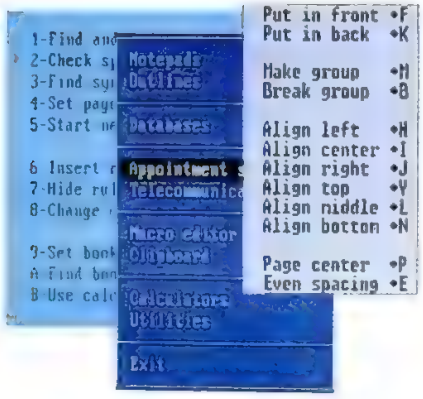

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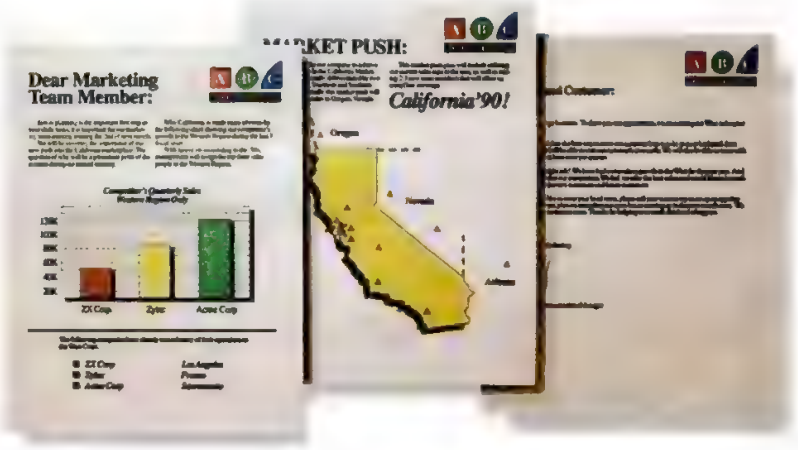

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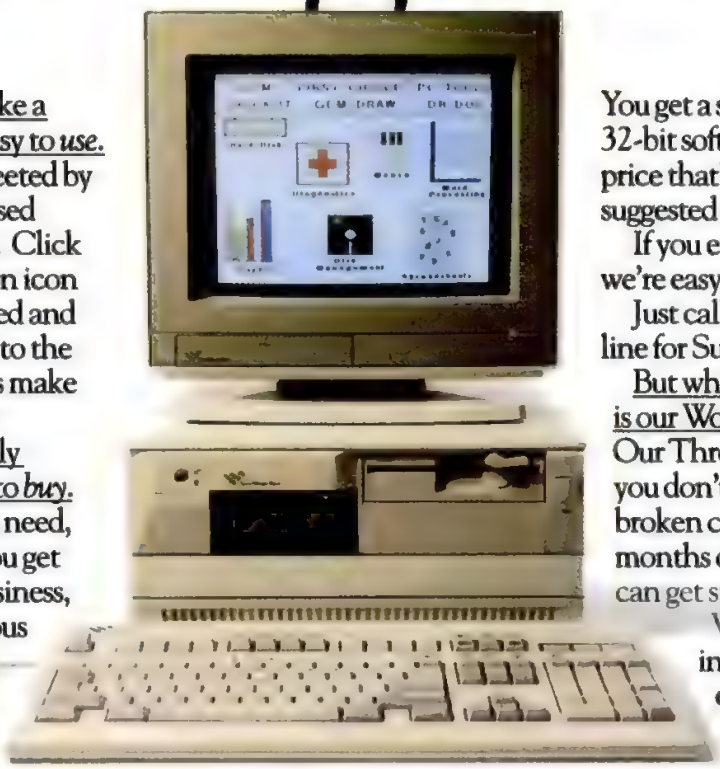

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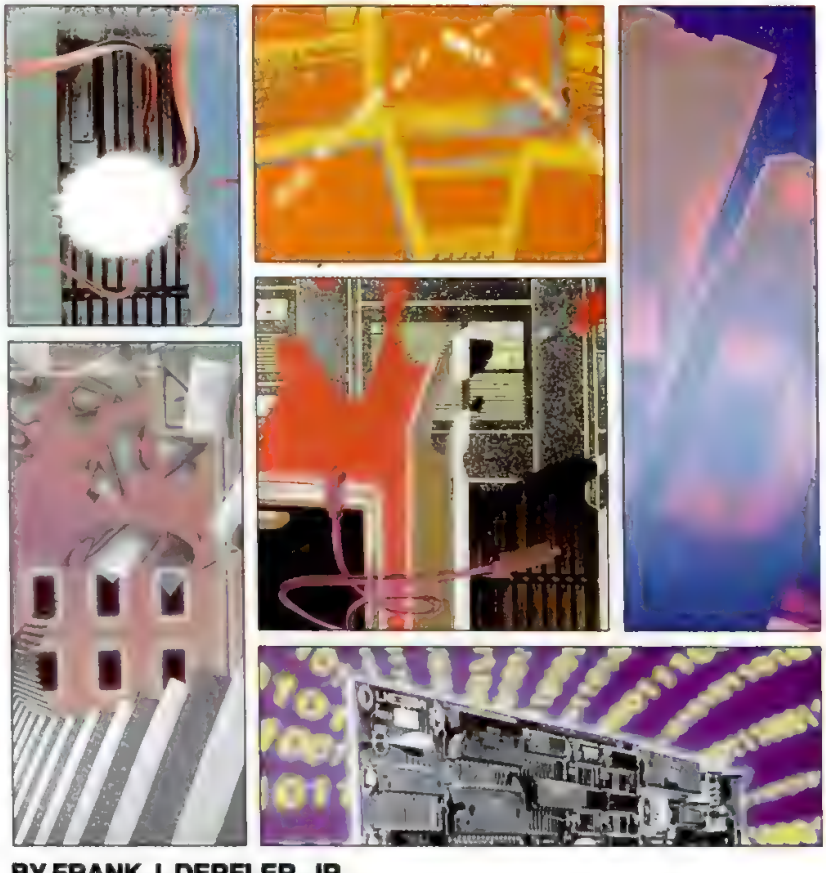
THE LAN SURVIVAL GUIDE

If your organization isn't networked yet, it will be soon. In this special issue, *PC Magazine* takes you on a tour of the hardware and software that will come together to build this decade's most powerful and economical PC-based LANs.



PHOTOGRAPHIC ILLUSTRATIONS: BILL LONGCORE

BY FRANK J. DERFLER, JR.

Still intimidated or confused by local area networks? You shouldn't be. The PC-based LAN market is full of mature and reliable products, the technology isn't difficult, the companies provide help if you need it, and the advantages are clear. Networks of PCs can share a single printer, displace, replace, or complement minicomputers, and link you to mainframes or huge databases.

With all these benefits and more, it's no wonder that an extensive survey of *PC Magazine* readers shows that nearly 50 percent of all PCs have some communications capability and over 20 percent are on networks. Over 63 percent of the surveyed readers report that their organizations have LANs installed.

The pieces and parts of a PC-based LAN can cost between $250 and $800 per node, not counting the price of each PC; in addition, the network cabling can

range from a few dollars to a thousand dollars per node. Yet companies have committed themselves to networks because they know that LANs improve personal and workgroup productivity and provide shared access to expensive resources. This helps to recapture their installation costs quickly.

Two articles in this issue of *PC Magazine* focus on the products at the core of this market: LAN operating systems. As a class, these systems have metamorphosed from ugly caterpillars into lovely butterflies in the past year. Products that previously needed the experienced hand of a specialist are now easily mastered by anyone with a working knowledge of DOS.

In addition to operating systems themselves, we take an in-depth look at high-powered network servers. Executive editor John Dickinson spent weeks at PC LAN Labs in Florida, up and down Silicon Valley, and across the Texas plains capturing and taming these "super servers." He reports on the technological breakthroughs in new 386- and 486-based machines with multiple processors and other performance enhancements.

We also measure the ability of PC-based networks to beat minicomputers at their own game. Senior editor Lee Thé, experts from the accounting firm of Price Waterhouse, and several companies specializing in accounting software all subjected many different kinds of PC-based LANs and a minicomputer to an extensive set of real-world multiuser accounting benchmark tests.

Articles on 32-bit network adapters and handy ways to enhance network printing round out our coverage.

NETWORKS = SHARING

You install and manage networks so that people working at PCs can share printers, mainframe connections, data and program files, CD-ROM infobases, modems, fax boards, and other devices. In a network, a computer acting as a server hosts a resource and makes it available to other linked PCs. Networks can include three general types of servers: file, print, and communications.

Sometimes file, print, and communications services reside in one computer, and sometimes the tasks are spread among many PCs. In networks designed by companies such as AT&T, Banyan, and DEC, one PC makes lots of services available to others. One Banyan server can provide shared file access, communication links to a mainframe, and long-distance links between servers using X.25 technology.

Companies like Microsoft and Novell design their network operating systems so that many PCs can act as servers of various types, even while people use them to run standard applications. In a Novell network, the file and printer services typically reside on one computer while others act as communications servers.

Database servers, a subset of the file server category, include those servers that make expensive hardware such as CD-ROM or optical drives available, as well as "back-end" database processors. The latter machines process special commands, often in IBM's Structured Query Language (SQL), from databases running on networked PCs. They receive simple requests for reports from the client stations and execute the complex code needed to extract and compile them from the raw database. This reduces the communications load on the network and puts the heavy I/O processing activity close to the mechanical storage devices doing the retrieval.

You install and manage networks so that people working at PCs can share printers, data and program files, CD-ROM infobases, fax boards, and other devices.

The term *communications server* includes a variety of types: PCs that let all networked stations share a rack of expensive high-speed modems, those that act as a shared gateway to mainframe communications, and those that route appropriate network packets over public data networks to distant locations. Fax servers, providing everyone with the ability to share the hardware for incoming and outgoing facsimile transmissions, make up another category.

All these servers make possible the applications that provide the functional and economic rationale for installing a network; the ability to share information and the efficiencies provided by electronic-mail or workgroup-scheduling programs all justify a LAN. Of course, servers need special software—the LAN operating system—to handle the many tasks involved in sharing resources.

SOFTWARE HOLDS THE KEY

A LAN operating system really is a *system* of separate, interacting parts. These include the software modules working in every networked client workstation and the modules found in each server.

Operating-system modules in the client stations include the redirector and the software elements that carry the redirector's output through the network. The redirector modifies DOS in the client stations so that certain requests from applications go out the network adapter for action instead of going to local disk drives or I/O ports. You program the redirector through a menu or a command-line prompt to route all requests addressed to a specific drive letter or I/O port to a selected network resource.

The other network software in the client moves the application's request for service from the redirector onto the network cable. This software has three parts: an application program interface (API), a network communications section that follows a specific protocol, and drivers customized for the LAN adapter.

The standard API provides the redirector (and certain classes of applications that make direct calls to the API) with a way to send and receive requests to and from the network. Some operating systems provide only one API for the transport-layer software, typically the NetBIOS API using software interrupt 5C hex. Novell has a unique API for its IPX (Internetwork Protocol Exchange) transport-layer software, but an optional module accepts calls from application programs using the NetBIOS 5C hex interrupts and translates them to IPX. Microsoft *LAN Manager* networks can use another API called Named Pipes for special node-to-node applications, and particularly for access to communications servers.

The communications portion of the transport-layer software follows standard protocols—perhaps NetBIOS, TCP, or Novell's IPX—to move information from one network node to the other. Some products, like *LAN Manager*, can load instructions for different protocols on demand, so that the transport-layer software can communicate using one of two or three protocols depending on the source or destination

of the particular packet of information.

Because the driver software is unique to each hardware card, adapter manufacturers usually provide the transport-layer software or include code that you compile into a complete module. Western Digital, for example, includes with its Ethernet adapter a floppy disk that contains driver software compatible with dozens of communications-protocol-and-API combinations.

The client stations' redirector and transport-layer software could take as much as 50K to 70K RAM, as it does in Novell *NetWare* stations. Other operating systems, like those from Artisoft and D-Link Systems, load part of the code in memory outside of the 640K used by DOS, taking only 4K to 10K away from it. Optional operating-system pieces that might also reside in the client PC include a menu to program the services, electronic mail, and station-to-station chatting.

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Servers have the same kinds of transport software layers as workstations. The server also runs software that buffers and queues requests for service from the network stations. The server software typically includes some kind of security protection based on either a password attached to each resource or a table of rights assigned to each named user.

HOW SOFTWARE IS SHARED

The sharing software in file, print, and communications servers comes in many different modules. Communications servers run software that translates between the network and whatever communications speeds, data alphabets, and protocols the external connections use. File-server software includes sophisticated queues for requests and usually some kind of disk cache. Disk caching loads large segments of the data from the hard disk into RAM to satisfy requests from fast memory instead of from the slower hard disk.

File servers might use DOS to access their files, but only for the sake of simplicity and economy. DOS is not a multitasking operating system, and it doesn't provide the fastest access to files. High-performance LAN file-server operating systems, like those from AT&T, Banyan, DEC, DSC Communications, Microsoft, and Novell, handle multiple tasks at once and have very efficient hard-disk file formats that are capable of handling gigabytes of storage.

The choice of DOS or a multitasking operating system as the underpinning of the file server marks a significant difference between two kinds of LAN operating-system products. PCs running file-server operating systems based on DOS keep their ability to run standard applications at the same time. Since it is possible to share files or printers with the network and still run local applications, all PCs on the network can act as combination server/workstation "peers." We call these peer-to-peer networks. Multitasking file servers typically are not also used as workstations, although some—particularly *LAN Manager* servers—can technically run both file-server software and normal applications.

File-server software in peer-to-peer networks resides in the individual PC's memory and divides or "slices" the time of the processor between file services and the standard applications. The RAM left for applications is typically about 400K, and the programs run more slowly than normal, but many people happily share drives and printers on multiple networked PCs using peer-to-peer systems (see "Making Do with DOS" in this issue).

Network operating systems have many component modules, but today's software isn't difficult to install, and the default installation parameters usually provide excellent operation. LANs based on multitasking operating systems often have more features and options, so configuring the software is more difficult. Yet with careful attention to the manuals, anyone comfortable with DOS can install and manage these systems.

Security is a top consideration for most organizations. You often need to limit the activity of network users to certain files to prevent both physical mischief and inadvertent damage.

THE SECURITY QUESTION

Security is an important consideration for most organizations: no one wants an unauthorized employee reading payroll records. You often need to limit the activity of network users to certain files to prevent both mischief and inadvertent damage. Physical security of the server is another important consideration: if someone can access all its files from the keyboard, the potential for catastrophe is high. Transmission security deserves equal consideration, as even relatively inexpensive network analyzers can capture and decode passwords as they fly across the network.

A LAN software package typically uses one of two types of file security plans (*LAN Manager* makes both techniques available). The first plan gives each shared resource on the network a "network name";

THE WELL-CONNECTED ENTERPRISE

DEDICATED MULTITASKING NETWORK OPERATING SYSTEM

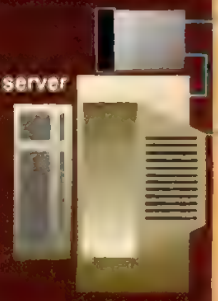
A network using a multitasking LAN operating system like Novell's *NetWare* or Microsoft's *LAN Manager*, along with specialized file and communications servers, can support 100 to 200 client stations running accounting, database, word processing, mainframe communication, and other applications. A network this complex will probably require a full-time administrator, at least initially. Establishing an on-call support agreement with a systems integrator is a smart idea.

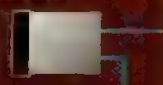
This file server, running a multitasking network operating system, is dedicated to making files and printers available to clients on the network. Typically equipped with 4MB to 8MB of RAM, big and fast hard disks, and a 32-bit adapter using EISA or Micro Channel bus technology, the server and its software will typically cost $5,000 to $15,000, though you can invest much more.

One PC on the network, often running OS/2, processes requests for complex database retrievals from client stations. This database server minimizes traffic on the network and increases response times. Alternatively, you can put database server functions in the file server. That decision depends on the load each machine carries and the type of LAN operating system it uses.

The MHS server is a communications machine running Action Technologies' Message Handling Service. This server can be any type of PC, even an old XT. It links this LAN's electronic mail system(s) with other PC network, mainframe, and minicomputer e-mail systems and with fax systems as well.

The SNA gateway is another form of communications server. In this case, a simple PC has an adapter and software allowing it to communicate with IBM 3270 SNA mainframe systems. Individual client PCs on the network run terminal emulation software that uses the 3270 sessions made available by the gateway.



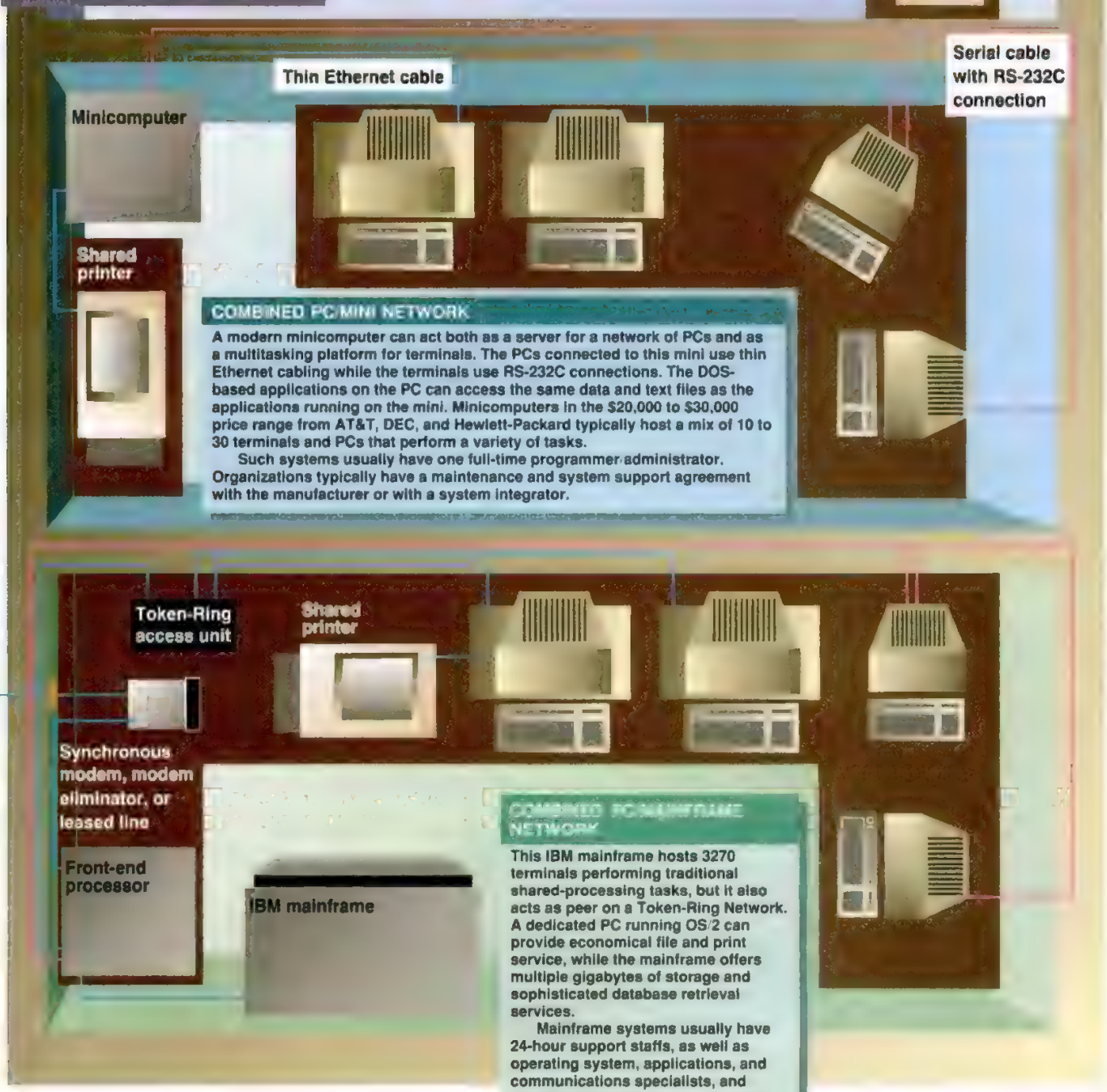


DOS-BASED NETWORK (NO DEDICATED SERVER)

In an inexpensive "peer-to-peer" network like this, each PC can make drives and printers available to all other PCs. Since DOS can't handle multiple simultaneous requests, PCs that make resources available lose some of their processing power, and they can also lose up to 150K RAM to server software.

You can build very complex multiserver, multiclient systems with this architecture, but it is more typically used with 2 to 12 nodes. Prices range from $200 to $500 per node. This type of network could also use database, MHS, and SNA gateway servers like those shown in the multitasking LAN topology.

In this type of LAN, one person usually acts as part-time system administrator. Telephone support from the LAN software vendor is adequate to keep things running smoothly. Examples of the operating systems for such LANs include *LANtastic* and *LANsmart*.



COMBINED PC/MINI NETWORK

A modern minicomputer can act both as a server for a network of PCs and as a multitasking platform for terminals. The PCs connected to this mini use thin Ethernet cabling while the terminals use RS-232C connections. The DOS-based applications on the PC can access the same data and text files as the applications running on the mini. Minicomputers in the $20,000 to $30,000 price range from AT&T, DEC, and Hewlett-Packard typically host a mix of 10 to 30 terminals and PCs that perform a variety of tasks.

Such systems usually have one full-time programmer/administrator. Organizations typically have a maintenance and system support agreement with the manufacturer or with a system integrator.

COMBINED PC/MAINFRAME NETWORK

This IBM mainframe hosts 3270 terminals performing traditional shared-processing tasks, but it also acts as peer on a Token-Ring Network. A dedicated PC running OS/2 can provide economical file and print service, while the mainframe offers multiple gigabytes of storage and sophisticated database retrieval services.

Mainframe systems usually have 24-hour support staffs, as well as operating system, applications, and communications specialists, and significant maintenance and system support contracts.

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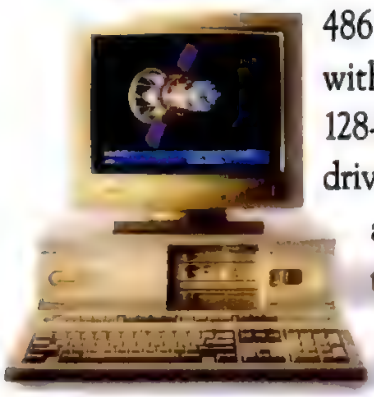

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a single name can designate a whole shared drive, a subdirectory, or even a file. You can associate a password with a network name and limit the read/write/create capabilities affiliated with that password. This scheme, used by DOS-based networks, makes it easy to shift the shared resources, but one user might have to keep track of several passwords. Security is easily compromised when password management is a constant headache.

The other security architecture uses the concept of groups: each person belongs to one or more groups and each group has specific access rights. This architecture, used by *NetWare* and *VINES*, makes each person responsible only for his or her password and lets the LAN administrator easily move people into different groups as they change jobs or leave the organization.

DOS-based networks have uniformly poor physical security for the server. Anyone who can get at the server's keyboard can access files on its hard disk. This problem is shared by early releases of *LAN Manager* but dealt with in Version 2.0. Servers using multitasking operating systems—*Advanced NetWare 286*, *NetWare 386*, *Nexos*, and *VINES*—don't allow access to files from the server. You must go through the network's security system to get them.

Encrypting passwords, both when stored on-disk and during transmission, is an important feature in high-security applications. Where previously a technician could easily attach a LAN analyzer to the cable and capture passwords and data files as they cross the network, *NetWare 386* now includes encrypted passwords to thwart such a scheme.

DEMYSTIFYING LAN HARDWARE

The mystery has gone out of LAN hardware. Thanks to the efforts of the IEEE and the availability of economical chip sets, a number of standards exist that improve the ability of adapters from different companies to interact on the same network.

Last year ("Low-Cost LANs," March 28, 1989), we evaluated LANs whose network adapters used wiring and signaling that did not meet IEEE or other industry standards, but we now believe the time for accepting proprietary signaling and cabling schemes is over.

There are enough varieties of the IEEE 802.3 Ethernet standard to meet any organization's need for noise-resistant fiber-optic cable, reliable coaxial cable, or inexpensive twisted-pair wiring. The IEEE 802.5 Token-Ring standard supports IBM's sophisticated LAN-to-mainframe architectures. An old accepted industry standard, ARCnet, is not anointed by the IEEE, but it works well and is economical.

The only justification for accepting a nonstandard LAN wiring scheme is cost. Some nonstandard LAN adapters cost less than $200 per station, but modern ARCnet and Ethernet adapters now approach that low price, and the small extra investment buys you a reusable and expandable network that doesn't depend on the future survival of one company.

Even though LANs have evolved and average PC users can install and manage them, things can go wrong. So remember, the support you will receive is a vital consideration.

Remember that the support you will receive is a vital consideration. Even though LANs have evolved and average PC users can install and manage them, things can go wrong. The adapters stretch to the limit the capabilities of many PCs to handle I/O jobs. You will sometimes find it difficult to install and configure applications because of incorrect paths, complicated user rights, buffers, and other problems. When you need help, it is worth a lot to know that a friendly voice is only a phone call away.

UNSTOPPABLE BANDWAGON

Dataquest, a Silicon Valley market research firm, has predicted that 60 percent of all PCs will be networked in some fashion by the end of 1992. The evaluations, benchmark tests, and features tables that follow will help you make intelligent choices as you take part in this headlong rush toward workgroup computing. In the past, the question was *whether or not* to network. Today, the question is *when* to network. The answer is now.

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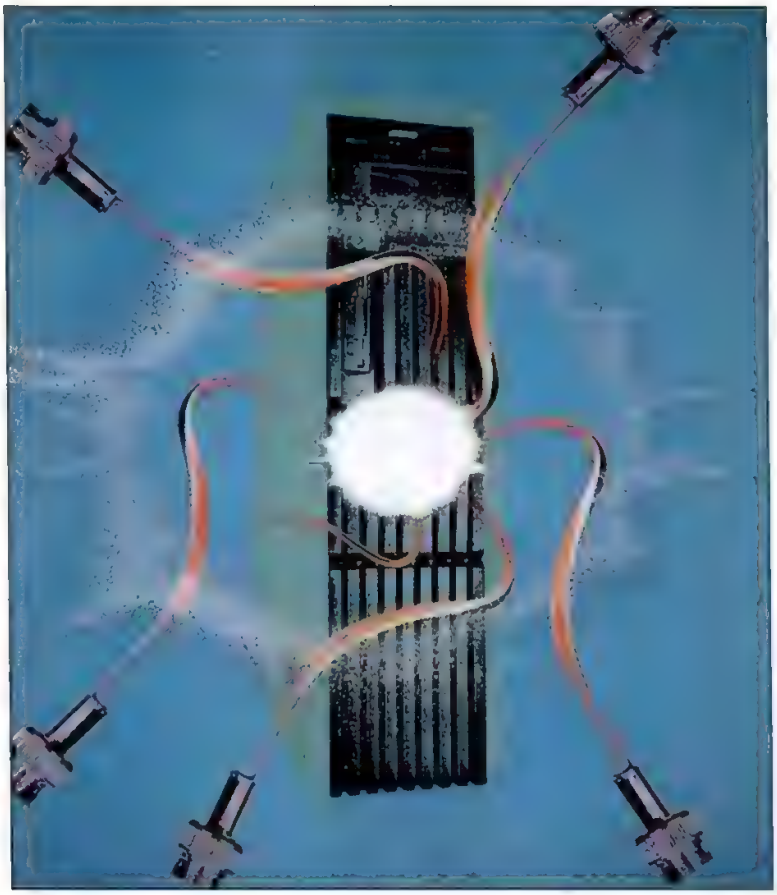
CIRCLE 243 ON READER SERVICE CARD

LAN OPERATING SYSTEMS:

The Power Behind the Server

Novell's NetWare is still the king of the multitasking LAN hill, but competition from newcomers and the impending release of several vendors' versions of LAN Manager 2.0 are forcing the monarch to keep up its guard.



PHOTOGRAPHIC ILLUSTRATION: BILL LONGCORE

BY FRANK J. DERFLER, JR., AND M. KEITH THOMPSON

PC-based LANs dominate the entire $3 billion PC-connectivity market. The LAN slice of the pie divides itself cleanly into two groups, centered around DOS-based and multitasking LAN operating systems. But the latter—which lets hundreds of nodes access gigabytes of data on a single server—sets the pace and direction of the industry, determining how people will connect to, across, and out of their network environments.

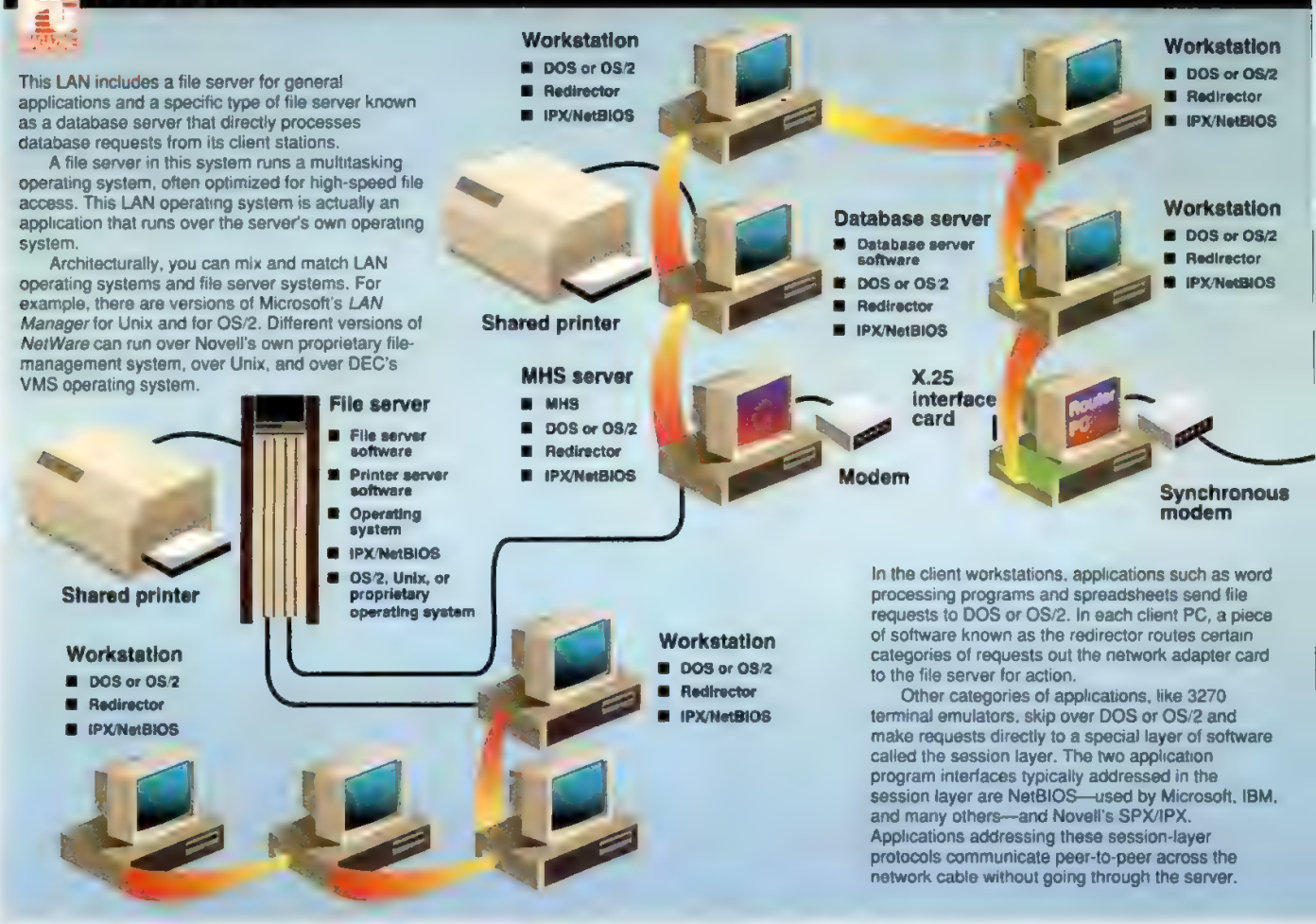
THE LAN SURVIVAL GUIDE

A DEDICATED MULTITASKING NETWORK OPERATING SYSTEM

This LAN includes a file server for general applications and a specific type of file server known as a database server that directly processes database requests from its client stations.

A file server in this system runs a multitasking operating system, often optimized for high-speed file access. This LAN operating system is actually an application that runs over the server's own operating system.

Architecturally, you can mix and match LAN operating systems and file server systems. For example, there are versions of Microsoft's *LAN Manager* for Unix and for OS/2. Different versions of *NetWare* can run over Novell's own proprietary file-management system, over Unix, and over DEC's VMS operating system.



In the client workstations, applications such as word processing programs and spreadsheets send file requests to DOS or OS/2. In each client PC, a piece of software known as the redirector routes certain categories of requests out the network adapter card to the file server for action.

Other categories of applications, like 3270 terminal emulators, skip over DOS or OS/2 and make requests directly to a special layer of software called the session layer. The two application program interfaces typically addressed in the session layer are NetBIOS—used by Microsoft, IBM, and many others—and Novell's SPX/IPX. Applications addressing these session-layer protocols communicate peer-to-peer across the network cable without going through the server.

Multitasking operating systems provide important options for flexible, secure, and reliable connections. A network of PCs running one of these operating systems could shove minicomputers out the back door in many organizations.

With the size of this market and the potential for profits, it's no wonder that competition is heated. As the nineties begin, Novell is no longer the only game in town. The current crop of network operating systems contenders haven't yet stolen a big chunk of Novell's market share, but with several *LAN Manager* vendors leading the way, the competitors are sinking more marketing and development dollars into their products.

Network operating systems developers have fueled recent growth in the marketplace by delivering products that operate under open standards. Instead of trying to lock in an account with unique communications standards, companies like AT&T, DEC, and 3Com lure buyers with software that works according to nationally and internationally accepted standards.

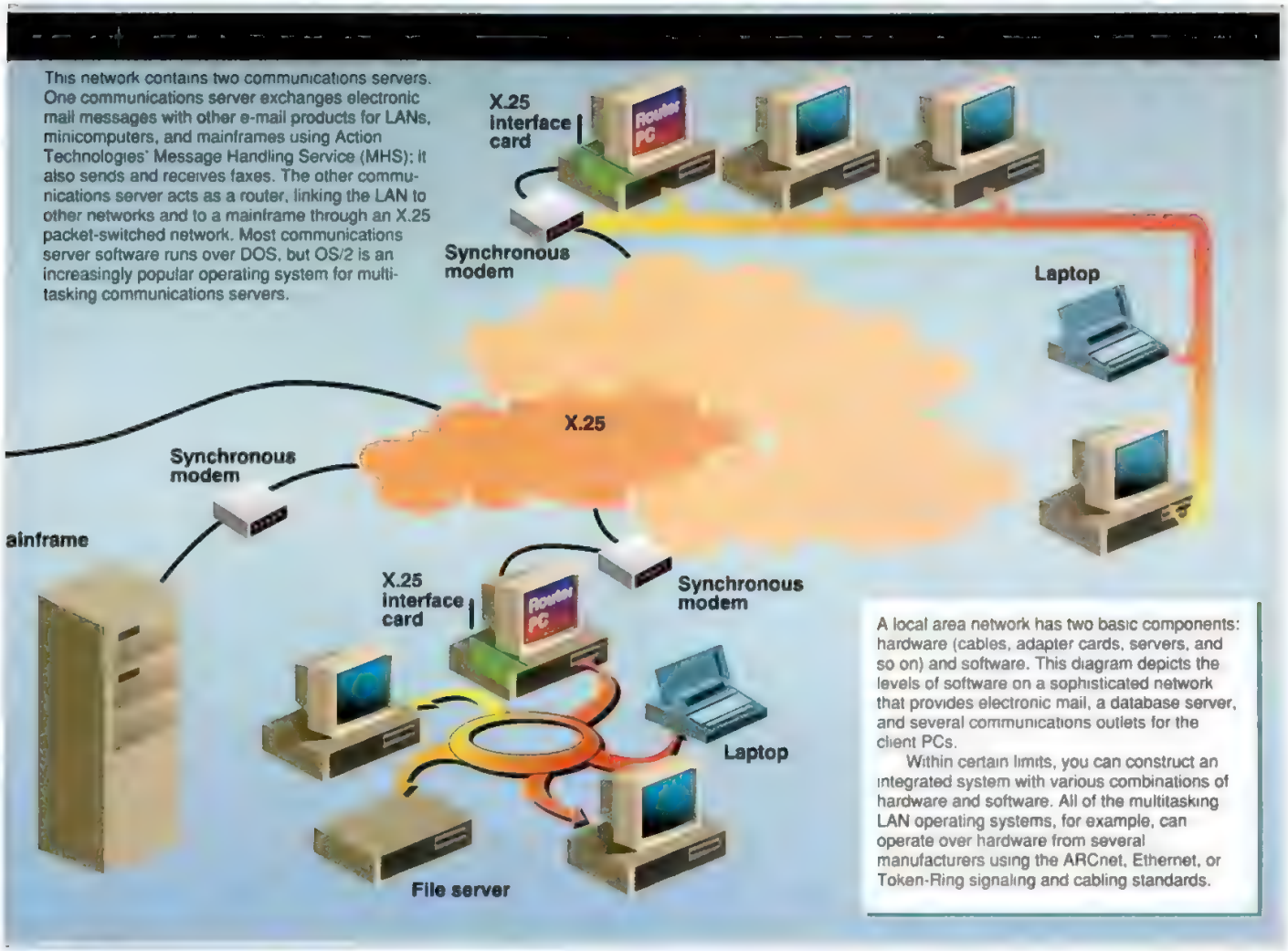
The trend doesn't stop there, however. Companies are now not only supporting open standards but also delivering software for each other's proprietary protocols. AT&T runs *LAN Manager* under Unix, and Novell's *Portable NetWare* can run under VMS, Unix, and—soon—OS/2. From 3Com, *3+Open LAN Manager*'s Demand Protocol Architecture (DPA) supports many different protocols, including *NetWare*, DECnet, and others. *3+Open LAN Manager* loads and unloads protocol stacks as needed for each data transfer.

THE NEW LAN MANAGER AND THE NEW UNIX

As we finished these evaluations, Microsoft was delivering final beta copies of the OS/2-based *LAN Manager* 2.0 to its resellers. *PC Magazine* doesn't normally mention products that are not commercially available, but the change from *LAN Manager* 1.1 to 2.0 is more than an upgrade—it's a significant event.

The original implementation of *LAN Manager* was not strong enough to compete with *NetWare*; lack of security and mediocre performance prevented it from becoming the big hit that Microsoft and IBM expected. But *LAN Manager* 2.0 is a whole new ball game. This time, Microsoft came to the plate with a big stick. Criticisms leveled at the earlier version have been addressed, and Microsoft particularly took to heart complaints about the product's lackluster security: the new *LAN Manager* is as secure as anyone else's product.

According to Novell, OS/2's place is in the minor leagues on user desktops, not in the major leagues with *NetWare*. Consequently, while Novell expects to lose some of the market share to *LAN Manager*, it doesn't see that product taking away a large portion of its sales. Of course, if the



This network contains two communications servers. One communications server exchanges electronic mail messages with other e-mail products for LANs, minicomputers, and mainframes using Action Technologies' Message Handling Service (MHS); it also sends and receives faxes. The other communications server acts as a router, linking the LAN to other networks and to a mainframe through an X.25 packet-switched network. Most communications server software runs over DOS, but OS/2 is an increasingly popular operating system for multitasking communications servers.

A local area network has two basic components: hardware (cables, adapter cards, servers, and so on) and software. This diagram depicts the levels of software on a sophisticated network that provides electronic mail, a database server, and several communications outlets for the client PCs.

Within certain limits, you can construct an integrated system with various combinations of hardware and software. All of the multitasking LAN operating systems, for example, can operate over hardware from several manufacturers using the ARCnet, Ethernet, or Token-Ring signaling and cabling standards.

The ability to use the Unix machine as a full multiuser platform as well as a network server should give potential OS/2 buyers something to think about.

companies making up the *LAN Manager* team work hard, they could end up with a big success on their hands.

Meanwhile, we have been impressed by the new releases of Unix from AT&T and SCO. These two companies, along with Microsoft, worked to deliver "merged" versions of Unix that can all use the same compilers and provide the same services. This gives people who write and re-host applications a broad base of operating systems to shoot for. In its favor, SCO Unix is easier to install than OS/2 and is less RAM-hungry. The ability to use the Unix machine as a full multiuser platform as well as a network server should also give potential OS/2 buyers something to think about.

LAN SYSTEMS IN ACTION

Although we call these products LAN operating systems, the term is slightly inappropriate. In fact, these products are sophisticated applications that run over a file-management system. Most of the time, the application and file-management systems are unique and tightly integrated, but sometimes—as in the case of *LAN Manager* and some versions of *NetWare*—the application runs on top of standard multitasking operating systems.

None of these products, however, rely on DOS as the operating and file-management system. Instead, they rely on multithreaded task managers that can handle multiple communications and processing tasks at the same time. These have a much firmer footing than DOS does for supporting heavy data loads.

In the performance arena, all the systems we reviewed behaved well enough to meet almost any computing needs. Under a heavy network load equivalent to the activities of 200 typical workstations, the slowest system still lets a client station retrieve a 50K file from the server in 1.4 seconds—about the same performance as you would get from an AT's hard disk. Under a lighter network load, you'll get better file-retrieval times from these systems than you would from the hard disks in typical 286-based desktop machines.

Our testing highlighted the point that a server is an interactive and relatively homogeneous system. It's difficult to comment on the importance of one part of the system without commenting on other sys-

tem parameters. For example, with today's drives, disk controllers, software, and LAN adapters, the speed and type of the processor don't make much difference when you get up to a 20-MHz 386. Witness the performance of our veteran IBM PS/2 Model 80, shuffling along with its "old and slow" 20-MHz 386 processor, in the face of its whippersnapper competition: the special Core hard disks and controller helped the Model 80 to compete well with 25-MHz 486 and 33-MHz 386 upstarts.

Investing in an expensive server with an MCA or EISA interface does you little good if your hard disks and controller aren't adequate. However, the amount of processing power and the interface bus you buy *will* account for a significant difference in the coming years when you run more tasks in the server and install faster hard disks.

EDITOR'S CHOICE

- **NetWare 386**
- **Advanced NetWare 286**

NetWare 386 won a *PC Magazine* Award for Technical Excellence at the end of 1989, and the results of this evaluation make it clear why. As the benchmark tests show, *NetWare 386* is the top performer no matter what platform you run it on.

If you don't need the huge storage capacity of the $7,995 *NetWare 386*, then *Advanced NetWare 286* ($3,295) is an excellent economical alternative. All of the *NetWare* LAN operating systems are fast and reliable. Their flexibility is excellent, and *Advanced NetWare 286* has become easier to install.

LAN Manager 2.0, in all its flavors, is an emerging alternative to *NetWare*, but it will need months of shaking down in the marketplace before we can recommend it or decide which of its several incarnations is the best.

The unexpectedly attractive alternative for performance, ease of installation, and flexibility is *POWERserve* from Performance Technology. Offering NetBIOS and SMB compatibility, *POWERserve* works with many third-party products in the field of communications and network services.

WHAT THE TESTS TELL US

For this evaluation, we omitted the Network Throughput Under Load test, since we used the same cabling and adapter setup all the way through, and we weren't interested in the network contention numbers. We do provide the results of our Hard Disk Access Load test because it gives the server system the best workout. These numbers correlate well with the tests conducted on some of the same systems by the *PC Magazine* Price Waterhouse team (see the article "Can LANs Beat Minis?").

Through a survey of more than 170 networks (Connectivity Clinic, *PC Magazine*, February 13, 1990), we've satisfied ourselves that one machine running the Hard Disk Access Load test sends at least 20 times the number of requests for action to the server each minute that an average PC on an average network does. During our tests, it isn't unusual to see our LANalyzer report that the Ethernet network is carrying over 6 megabits per second for sustained periods. This is 60 percent of Ethernet's theoretical limit and practically unheard of in real installations. So, even though the number of client machines looks small, they generate a heavy network load.

We took two different approaches when testing these products. If the company markets a server, we tested its software on its own server; if the company doesn't, we used one of our available servers. This means that the differences in performance times cannot be totally attributed to the software. But since you are likely to buy your software vendor's server—or at the very least run the software on a similar machine—the comparison is fair. All of these servers are husky and formidable pieces of machinery.

Since Novell no longer markets a server of its own, we ran its software across a variety of platforms. The ALR 486 MCA and EISA machines proved their value as *NetWare* servers. (These computers, along with a combination of fast hard disks, special 32-bit Novell network interface cards, and 25-MHz 486 processors, offer significant growth potential.) Note that *NetWare 386* "took a licking and kept on ticking," especially on the NetFrame and ALR machines. Under a heavy load, these systems moved data quickly. The NetFrame's split-input processors significantly improved throughput by reducing network conflict.

Neither Novell nor Banyan had software capable of using the Compaq Systempro's multiple processors, so the machine ran with a single processor. Since many people don't need or can't afford *NetWare 386*, we also tested Novell's *Advanced NetWare 286*, Version 2.15. We used a specially configured server, the Storage Dimensions File Master, to show what *Advanced NetWare 286* can do in the face of some rugged competition.

The hot buzzword in the LAN operating system market is client/server computing. This technique lowers network traffic congestion, but it increases the load on the file server's processor.

While nodes now need only 50K to 70K (unlike the old days, when workstation redirector software used more than 100K), servers running these LAN operating systems want as much memory as they can get. For example, *NetWare 386* will work in a server with 2.5MB of RAM, but it prefers 4MB; while *LAN Manager* operates well with 4MB, Microsoft suggested that we use 10MB when we installed it on our servers.

CYCLICAL GROWTH

The hot buzzword in the LAN operating system market is client/server computing. In client/server architecture, certain disk-intensive tasks stay on the file server. This technique lowers network traffic congestion, but it increases the load on the server's processor.

As you load more jobs onto the file server, it requires more RAM and processing power. As you gain power in the server, you can add more features in the LAN operating systems. The cycle keeps repeating itself. New software, which is usually chasing the power of the new hardware, will increase the importance and presence of network operating systems in an ever-growing web of computer interconnections.

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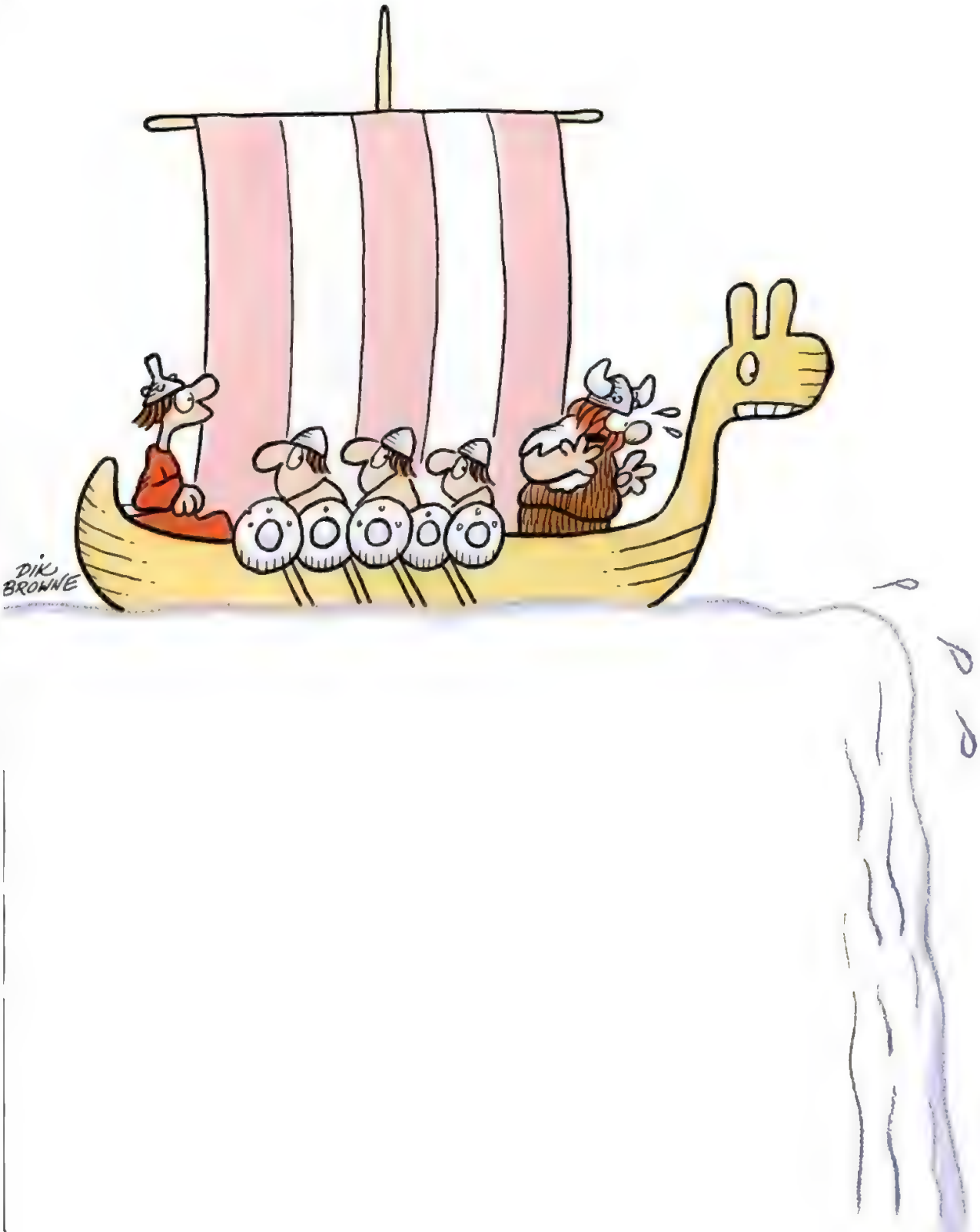

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	MFLOPS	MIPS	SPECmark™
POWERstation 320†	7.4	27.5	22.3
DECstation™ 3100‡	1.6	14.3	10.1
SPARCstation™ 1‡	1.4	12.5	8.4

†MFLOPS are the results of the double-precision, all FORTRAN Linpack test 100 x 100 array suite. The Dhrystone Version 11 test results are used to compute RISC System/ 6000 Integer MIPS values where 1757 Dhrystones/second is 1 MIPS (VAX 11/780). SPECmark is a geometric mean of ten benchmark tests.
‡Performance data are based on published benchmark information.

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MULTITASKING LANs: SUMMARY OF FEATURES

Products listed in alphabetical order

	Advanced NetWare 286	AT&T StarGROUP	LAN Manager, Version 2.0	NetWare 386	Nexos	POWERserve
List price	$3,295	$3,495	Set by vendor	$7,995	$3,295	$2,795
Number of users at the stated price	100	Unlimited	Set by vendor	Unlimited	255	255
SERVER OPERATIONS						
Hard disk format type	Proprietary	Unix	HPFS	Proprietary	Proprietary	DOS
Fault tolerance through disk mirroring	■	■	■	■	❑	■
Maximum number of network cards bridged in server	4	None	4	16	8	2
Maximum number of simultaneous log-ons	100	256	1,000	250	255	255
Recommended minimum server RAM	2MB	4MB	4MB	4MB	8MB	2MB
WORKSTATION SOFTWARE						
Maximum RAM left (within 640K) with DOS and network operating system loaded	540K	580K	525K	558K	525K	527K
With NetBIOS loaded as well	516K	580K	525K	516K	55K	527K
Compatible with OS/2 workstations	■	■	■	■	❑	■
FILE SYSTEM						
Maximum number of concurrent open files per server	1,000	Unlimited	16,000	100,000	65,025	10,000
Maximum number of volumes per server	32	N/A	24	32	1	24
Maximum number of physical drives per volume	1	N/A	1	32	2	Unlimited
Maximum number of physical drives per server	32	4	24	1,024	2	Unlimited
File can span multiple drives	❑	■	❑	■	■	■
Maximum file size	255MB	Unlimited	2GB	4GB	2GB	2GB
Maximum volume size	255MB	N/A	2GB	32TB	16GB	2GB
Maximum physical RAM addressed	12MB	64MB	16MB	4GB	4GB	32MB
Maximum total disk storage	32GB	1.6GB	48GB	32TB	16GB	48GB
ADMINISTRATION						
Keeps historical error/status log	■	■	■	■	■	❑
Reports number of bad packets	■	■	■	■	❑	■
Reports network errors	■	■	■	■	■	■
Monitors open files	■	■	■	■	■	■
Displays names of users logged on	■	■	■	■	■	■
Displays current server load as a percentage of total load	■	■	❑	■	■	■
SECURITY						
Access to network resources can be determined by group membership	■	■	■	■	■	❑
Access can be controlled by time and date	■	■	■	■	❑	❑
Passwords can be associated with network resource names	■	■	■	■	❑	■
Encrypted passwords can be sent over the network	■	❑	■	■	❑	❑
E-MAIL SERVICE						
E-mail system can store and forward messages	❑	Optional ($995)	❑	❑	❑	■
User can attach binary files to messages	❑	■	❑	❑	❑	■
System allows rude messaging	■	■	❑	■	■	■
PRINTING						
Print spooling is available	■	■	■	■	■	■
User can modify print queue	■	■	■	■	■	■
Number of printers supported	5	Unlimited	Unlimited	16	8	Unlimited
Workstation printers supported	❑	■	■	■	■	■
Fonts can be downloaded	■	■	■	■	■	■

— Editor's Choice ■ —Yes ❑ —No
MB = megabytes, GB = gigabytes, TB = terabytes.
N/A—Not applicable: the product does not have this feature.

3+Open LAN Manager	VINES	VMS Services for PCs
$3,495	$5,995	$12,500 (with PCLAN/Server 3100)
Unlimited	Unlimited	Unlimited
OS/2	Unix	Proprietary
❑	❑	❑
5	4	8
100	Unlimited	998
2MB	4MB	8MB
589K	600K	560K
589K	553K	560K
■	❑	■
8,000	200,000	2,048
26	12	9
1	1	255
12	4	9
❑	❑	■
2GB	Unlimited	4GB
4GB	Unlimited	357MB
16MB	24MB	32MB
4GB	2.4GB	3.1GB
■	■	■
■	■	■
■	■	■
■	■	■
■	■	■
❑	■	❑
■	■	❑
❑	■	❑
■	■	■
■	■	❑
■	■	■
■	■	■
■	■	■
■	■	■
■	■	■
32	■	Unlimited
❑	■	❑
■	■	■

AT&T StarGROUP

by Paul Ferrill

Version 3.3 of *AT&T StarGROUP* software ($1,895 for an eight-user license) provides our first look at the ability of Microsoft's *LAN Manager* to reside on a Unix platform. Although it carries the same name as the product we reviewed last summer ("AT&T StarLAN 10," *PC Magazine*, August 1989), it now represents the next generation in LAN operating systems.

When AT&T adopted the *LAN Manager* standard, it moved its *StarGROUP* software from a print/file-sharing environment into a true client/server model in which shared processing optimizes the use of network resources. The underlying operating system in the *LAN Manager* for Unix (LM/X) product provides an additional layer of security down to the file level for the entire network.

AT&T and Microsoft did a nice job bringing *LAN Manager* over to Unix. AT&T now gives its Unix machines the ability to act as servers for both DOS and OS/2 client stations on the network. Not only can the Unix system console run the administration programs, but NET ADMIN, which provides a windowing front-end to the *StarGROUP* system, allows any enhanced DOS or OS/2 client node to do the same. Other flavors of *LAN Manager* require an OS/2 workstation for system administration.

A program called NET, also available to OS/2 clients, allows the user to operate all network functions with a mouse. No prior knowledge of the operating system is needed to perform standard functions such as linking to remote file and print services.

The QuickMenus facility allows network administrators to create custom menus quickly and easily, saving users the trouble of learning sometimes complicated commands to access networked applications.

SUPPORTING THE STANDARDS

AT&T's *LAN Manager* for Unix supports all but four of Microsoft's Application Program Interfaces. Excluded from the list are the character-device APIs, but these will be available in Release 4 of Unix V.

The Network Driver Interface Specification (NDIS) developed jointly by Microsoft and 3Com is supported, allowing *StarGROUP LAN Manager Server* to handle a wide range of network access cards including IBM's Token-Ring adapters, 3Com's Etherlink and Racal-Interlan's LAN hardware, and AT&T NAU boards.

The *StarGROUP* software communications platform is based on the Open Systems Interconnect (OSI) model and currently supports the International Standards Organization (ISO) protocols up through the OSI transport layer in both the Unix and DOS environments. The NetBIOS application programming interface, which has become industry-standard for the DOS environment, and the Unix Transport Interface, an AT&T Application Operating Environment (AOE) standard, are supported on top of the OSI transport.

Despite its new reliance on *LAN Manager*, AT&T's system supports previous versions of *StarGROUP* software, so any applications developed prior to Release 3.3 should run without problems. Established users can relax knowing that the commands used in previous versions remain. Additionally, the continued compatibility means that client stations running Release 3.2 can communicate with the server without changing software. This provides a smooth migration plan and little turmoil for the installed customer base.

The recent release of the IEEE 10Base-T specifications for Ethernet over twisted-pair wiring is also a benefit to AT&T. Its StarLAN cabling systems have led the twisted-pair LAN industry, and ease of wiring is a significant advantage built into the AT&T adapter cards. This advantage goes hand in hand with one potential problem, however: the StarLAN AT&T adapter cards are all full-length, which could limit their usability in some installations.

FACT FILE

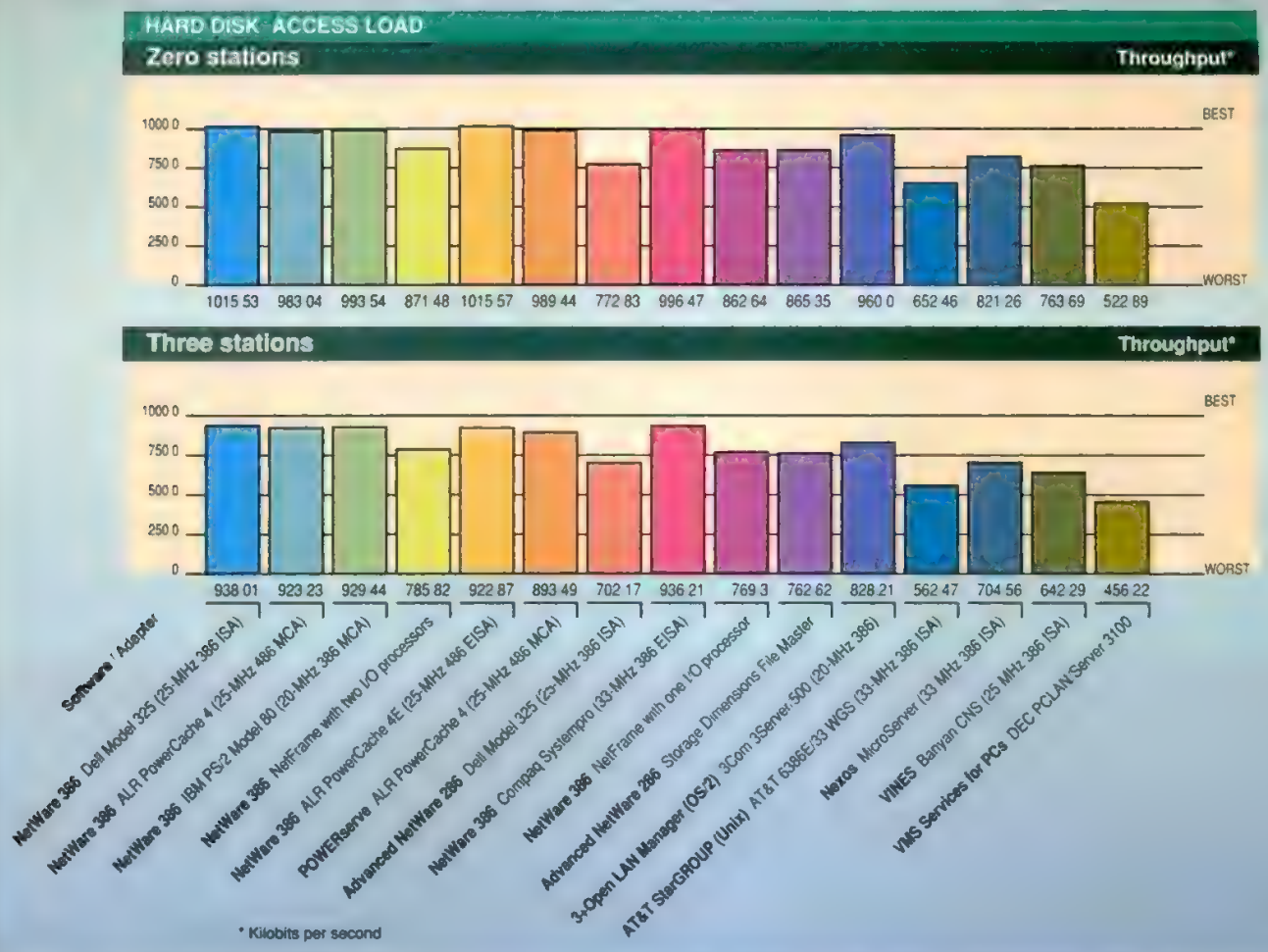
AT&T StarGROUP, Version 3.3
AT&T Information Systems, 1 Speedwell Ave., Morristown, NJ 07960; (800) 247-1212.
List Price: *StarGROUP LAN Manager Server* for 8 users, $1,895; unlimited users, $3,495; 6386E/33 WGS system (33-MHz 386 processor, 8MB RAM, 135MB hard disk), $15,794.
Requires: Unix, 4MB RAM, DOS 3.1 or later on stations.
In Short: The new wave in LAN operating systems, *AT&T StarGROUP* is *LAN Manager* for Unix and OS/2. It's exciting and innovative, but don't try to use it with DOS if you need a lot of RAM. The menu interfaces and windowing environment of OS/2 make long network commands a thing of the past.

CIRCLE 407 ON READER SERVICE CARD

BENCHMARK TESTS: MULTITASKING LAN OPERATING SYSTEMS

Novell's *NetWare 386* leads the field in performance, regardless of what server it is on. As these numbers show (and the Price Waterhouse LAN-versus-mini tests confirm), MCA machines usually outperform EISA systems—especially when Novell 32-bit adapters and the right driver software are used.

The **Hard Disk Access Load** test heavily loads the hard disk and disk-caching system. Each load station randomly accesses its own 100K data file using 1K records, changing the data each time, while the timed station transfers files. This test is sensitive to the algorithms used in the cache scheme, the software's efficiency in handling the drive, and the speed of the drive and controller.



BASIC AND BEYOND

In addition to OS/2 and enhanced DOS clients, *StarGROUP* also supports basic DOS clients. The basic DOS client cannot use the *LAN Manager* API suite, nor can it use the NET ADMIN full-screen interfaces. It also has only a small subset of the NET command line commands.

Less favorable to the enhanced DOS client is that it has only 420K RAM free without EMS, or 464K with EMS. The basic DOS client has a little more: 450K RAM without EMS or 508K with. You won't be able to run some RAM-hungry applications and the enhanced DOS client at the same time.

Even running on a husky 33-MHz 386 AT&T 6386E/33 WGS with 8MB RAM, the *StarGROUP* software didn't set any performance records, but it did handle our heaviest testing load nicely and should easily do the work required by a hundred or more PCs in daily operation. In addition, you can connect RS-232C terminals to the Unix system and share files between Unix applications and those stored by *LAN Manager* client stations.

AT&T service is summed up in one word: complete. AT&T offers the industry-standard 90-day warranty, including a toll-free hot line for questions and advice. Basic warranty holders have access to the hot line during regular business hours; a 24-hour hot line is available for extended-warranty holders.

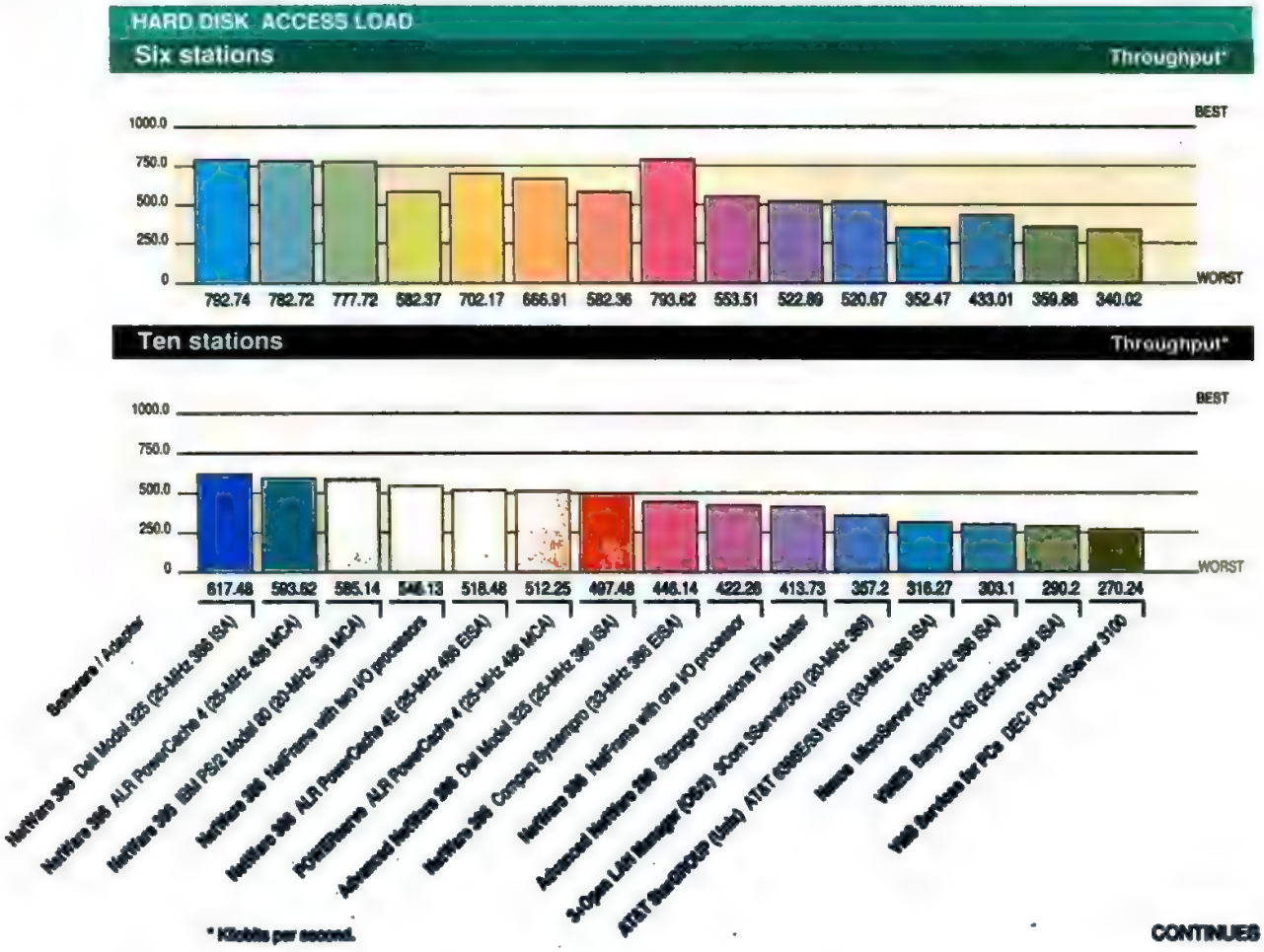
The AT&T *StarGROUP* package provides a Unix-based file server running *LAN Manager* with downward compatibility to previous versions of the *StarGROUP* software, and the availability of DOS and OS/2 clients makes connecting PCs a snap. The only hitch in the whole scheme

Thin Ethernet cabling and 3Com EtherLink II adapters were used for all of these operating systems except the AT&T and DEC products, which used their own adapters and cabling.

We outfitted EISA and MCA servers with the appropriate Novell 32-bit adapters. ISA servers used 3Com 3C505 16-bit adapters or adapters supplied by the individual network vendors.

A variety of PCs, none slower than a 12-MHz 286, were used as stations to load the network. We monitored network loading and errors using a Novell LAN analysis utility. During the ten-station-load tests, Ethernet loading of more than 60 percent of capacity was typical. Our surveys indicate that the network activity generated in the ten-station-load test is equivalent to that of 200 typical networked stations.

All of the tested software runs under DOS except as indicated.



CONTINUES

is the reduced RAM available in various DOS-client versions. If you can live with that, you'll enjoy the quality and service AT&T's latest LAN venture offers.

LAN Manager, Version 2.0

by M. Keith Thompson

Versions 1.0 and 1.1 of Microsoft's *LAN Manager* lacked the features necessary to lure the faithful away from Novell or to inspire trust in purchasers of new network systems. Microsoft accepted the industry's criticism of its first attempt, went back to the drawing board, performed some major surgery, and is now preparing to launch a high-quality network operating system: *LAN Manager* 2.0.

This prereview focuses on the generic *LAN Manager* 2.0 beta code we've run in PC LAN Labs. By the time you read this, the real live *LAN Manager* 2.0 should be available, with varying enhancements, from companies like AT&T, Compaq, Hewlett-Packard, IBM, NCR, 3Com, and Ungermann-Bass, and perhaps from a number of smaller regional value-added resellers.

The single-biggest improvement in *LAN Manager* 2.0 is a speed increase gained from Microsoft's new High Performance File System (HPFS). Microsoft departed from the original file allocation table (FAT) system developed for floppy disks more than ten years ago at a time when hard disks for PCs were rare. As hard disks became economical in the early 1980s, upgrades to DOS did not give it the

NetWare 386 sets new standards for performance, architecture, sheer power, and flexibility. *NetWare 386* is even 486-aware, the first commercial program to be so. It opens up

PC MAGAZINE, Jan. 16, 1990

Although such capacity in a PC LAN is breathtaking, it isn't Netware 386's only boon. Management woes have been greatly reduced. With dynamic resource configuration, a network manager can allocate RAM in real time.

LAN Magazine, Feb. 1990

Novell Netware 386

Novell upped the network ante in 1989 with a true 32-bit server operating system, Netware 386. This version features support for up to 250 users, easier installation and setup, an innovative and more

InfoWorld, March 5, 1990

Novell NetWare 386 (version 3.0) permits vastly greater numbers of users on a server, improves performance and security, and is significantly easier to install.

BYTE, January 1990

After everything that's been said about NetWare® 386,

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CIRCLE 322 ON READER SERVICE CARD

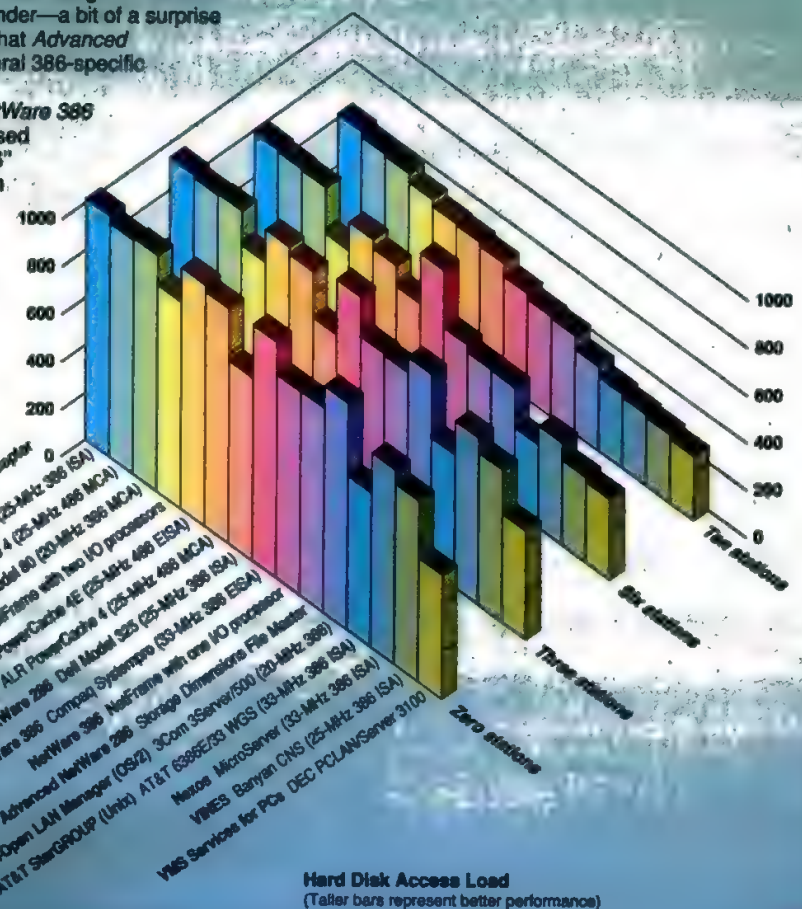
COMPOSITE VIEW: MULTITASKING LAN OPERATING SYSTEMS

NetWare 386 proved to be the best performer on a wide range of hardware platforms, while *POWERserve* was a strong contender—a bit of a surprise from a lesser-known operating system. Note also that *Advanced NetWare 286* provided better throughput than several 386-specific operating systems.

The Dell Model 325 server tested here with *NetWare 386* was the same system we used for testing DOS-based LAN operating systems (see "Making Do with DOS" in this issue). Flipping to those test results, you can see that *LANtastic*, the best peer-to-peer performer, was as efficient as some of these heavy-duty systems (830 kilobytes per second with no stations loaded, 527 kbps under the three-station load).

The Dell's throughput is so great because it uses a small 40MB hard disk formatted with a 1:1 interleave and small clusters. It has a lightning-fast track-to-track seek time. Obviously, this 40MB system's speed should not dissuade you from buying a Compaq Systempro or NetFrame, but it does demonstrate that there are several ways to get performance.

We ran the NetFrame with both one and two I/O processors (like LAN adapters) to demonstrate its capability to split a heavy load. Of course, you can add multiple adapter boards to any server for a similar effect, but multiprocessing is wonderfully simple on the NetFrame.



power to manage large amounts of data efficiently. *LAN Manager* 2.0, however, can handle gigabyte-sized files and heavy traffic loads. The standard Microsoft *LAN Manager* offering comes with two versions of HPFS: one for 80286- and another for 386- and 486-based computers.

LAN Manager supports dual processors by running any server-based application, such as *SQL Server*, on one processor and 386-specific versions of HPFS and the network I/O subsystem on the other. This explains why some speed tests are no faster with two processors than with one. If *LAN Manager* is the only task running under OS/2, the second processor stands idly by.

One of the nicest features any network operating system can offer—and *LAN Manager* does—is auto-connect. If the network goes down, auto-connect reestablishes the connection when the server comes back up. As long as the workstation wasn't expecting something from the server at the moment of failure, the user doesn't even know the connection was broken.

Installing *LAN Manager* on your server is simple and quick; easy-to-follow menus guide you through the program. Excluding hard disk formatting time, the whole process took us only 20 minutes. On the workstation side of things, setup was just as easy.

MANAGEMENT TOOLS

LAN Manager 2.0's centralized management features make administering large networks much easier. Network managers can logically group a set of servers together as one domain and administer it as a single server. This allows managers to change users' rights, passwords, and time restrictions on all servers at once instead of on each individual server. Managers can also safely delegate certain types of management tasks to others, such as disk backup or print queue management. Through the Remote Administration facility, network managers can easily do all of these things from any OS/2-based workstation. In contrast, administering the network from a DOS client is more difficult, requiring managers to tangle with many command line parameters.

The network auditing facility allows managers to monitor the use of any network resource. *LAN Manager* also logs error messages and network performance statistics useful in fine-tuning the server. While these statistics help administrators

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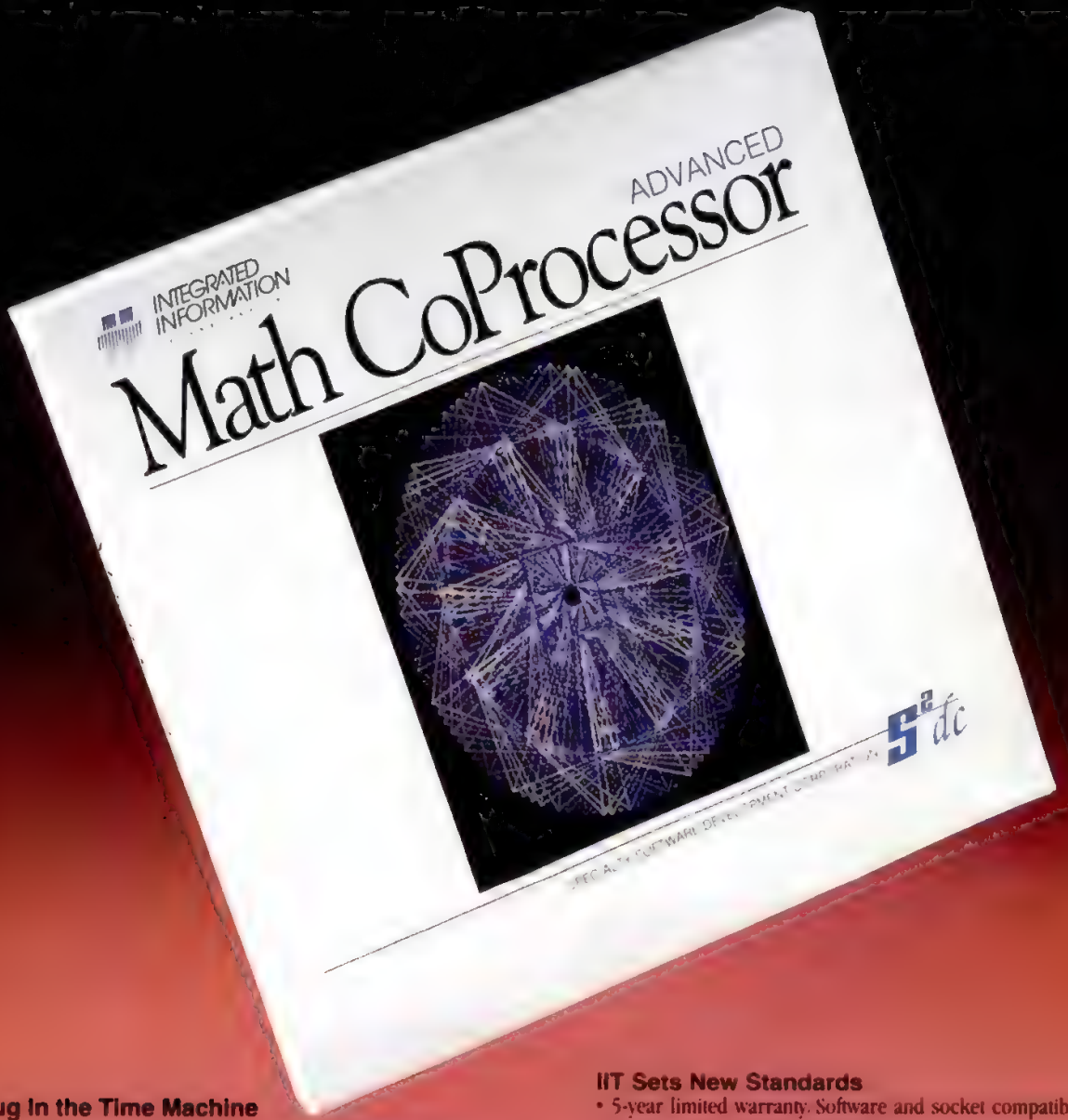

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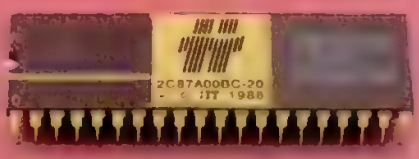

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change *LAN Manager* parameters, a self-running resource management facility like the one in *NetWare 386* would be a nice addition.

Such a utility tells the server to perform actions at a specific time each day or month. It can send messages and run programs at preset intervals, freeing the administrator to do tasks that require more thought.

LAN Manager now boasts a suite of features that match anything on the market, including built-in fault tolerance via drive duplexing, disk mirroring, and a new file replication system. File replication allows administrators to duplicate specified files across servers automatically at predefined intervals. HPFS, a function similar to *NetWare*'s HOTFIX, manages bad disk space and reroutes the data to other sectors.

When teamed with an uninterruptible power supply, *LAN Manager* protects the server from power failures (it communicates with a UPS through a standard RS-232 port). When the power goes out, the UPS signals *LAN Manager*, which in turn sends a warning to everyone on the network. If the battery drops below 10 percent before power is restored, the server shuts down safely.

LAN Manager's security system addresses all components of the network and is as comprehensive as any found in the competition. With LAN Man Account Control, administrators set valid log-on times, workstation IDs, and account expiration dates. The Forced Log-off action allows managers to deal with users who exceed their storage limit or whose account expires. Additionally, *LAN Manager*'s restricted access mode prevents someone who gains physical access to the server from locally booting it and accessing the files located on the hard disk.

LAN Manager's print spooler supports routing of jobs to any available printer in a group of similar devices, as well as time-delayed printing. Network managers reprioritize, delete, pause, and continue print jobs, both local and remote, through the OS/2 Print Manager. The facility also prohibits anyone who does not have proper security from modifying a print job.

A WEALTH OF SUPPORT OPTIONS

By using many industry-standard protocols, *LAN Manager* supports a variety of topologies on the same network. This fully modular architecture allows support for IBM NetBIOS Extended User Interface (NetBEUI), Open Systems Interconnect TP4, TCP/IP, and Xerox Network Standards (XNS).

Two other emerging standards are Named Pipes and Server Message Block (SMB). Named Pipes provides a programming interface similar to NetBIOS, but the API is more sophisticated and much easier to implement. SMB makes DOS more efficient over networks (see the sidebar "Server Message Block: DOS Shorthand for Networks" in the following article, "Making Do with DOS").

Microsoft bases *LAN Manager* 2.0's open design on the Network Driver Interface Specification (NDIS) codeveloped and copublished with 3Com. Since transport protocols and LAN adapter drivers are written to this standard, interoperability among different vendors' products is easy and works.

With *LAN Manager* 2.0, Microsoft moves from lightweight status to serious contender in the LAN operating system arena. A fast, feature-rich, and secure package, it provides a total solution for many organizations.

FACT FILE

***LAN Manager*, Version 2.0**
Supplied under several different names from a variety of vendors including AT&T, Compaq, Hewlett-Packard, IBM, Microsoft, NCR, 3Com, and Ungermann-Bass.
List Price: Depends on supplier.
Requires: 286 or 386 processor, 4MB RAM (6MB recommended), OS/2 1.2; other requirements depend on supplier.
In Short: Except that it communicates with existing *LAN Manager* networks and runs under OS/2, *LAN Manager* 2.0 does not resemble earlier versions. Excellent security, fast performance, and easy installation make it a serious competitor to *NetWare 386* for the first time.

CIRCLE 408 ON READER SERVICE CARD

NetWare 386 and Advanced NetWare 286

by M. Keith Thompson

Novell is the company to beat in the LAN software market. The top performance and reliability of *NetWare*, in combination with Novell's strategic marketing and development moves, have kept the product far ahead of its competitors.

Until the middle of 1989, *Advanced NetWare 286* ($3,295 for 100 users) had been the standard to which other network operating systems were compared. When the rest of the field started closing in on *NetWare*'s speed and security, Novell released *NetWare 386* (an unlimited-user license costs $7,995). By taking full advantage of the powerful 80386 and 80486 hardware sitting underutilized in many organizations, *NetWare* gained another furlong lead on the pack. An added benefit is that *NetWare 386* and existing *Advanced NetWare 286* servers can coexist on the same network, and you don't have to make any changes to the client workstation software to give them access to either.

In addition to *Advanced NetWare 286* and *NetWare 386* (the foci of this review), Novell offers three other levels of network operating systems. The Entry Level System (ELS) *NetWare* products provide solutions for small networks where cost is a concern. *ELS Netware I* and *II* let you set up single-server networks that do not need internetwork routing services and the safeguards of *Advanced NetWare 286* (see "Building Workgroup Solutions: Low-Cost LANs," *PC Magazine*, March 28, 1989). One machine on the network acts as a server/workstation and makes drives and printers available to the client PCs. ELS *NetWare* offers nearly all the features of its big brother, such as supervisor control, time-accounting capabilities, and file caching, but it's limited to eight simultaneous users.

Portable NetWare consists of portable C code of all the *NetWare* services and is licensed to computer manufacturers for integration into their operating systems. *Portable NetWare* provides companies that have a large investment in minicomputer hardware with a method of integrating personal computers into their scheme.

NETWARE ADVANTAGES

Novell's systems have always been noted for their top-flight performance. On our ten-station-load benchmark tests, *NetWare 386* running on a 25-MHz 386 Dell Model 325 led the pack (albeit with a very small hard disk). *Advanced NetWare 286* was not far behind when tested on the same system.

Besides speed, *NetWare* stands apart from other operating systems in terms of its security. Network managers can restrict

MICROSOFT OPENS THE LAN MANAGER DAM

by Jim Seymour

And the rich get richer . . . .

That's how some of Microsoft's largest OEM customers interpreted its decision (word of which leaked in late January) to begin selling *LAN Manager* this fall directly to some of those OEMs' distributors—and perhaps even to corporate customers.

While the dollar value of those non-OEM sales will at first be minuscule for Microsoft, in terms of the software giant's total revenues, the policy is widely seen as yet another step along a path toward selling directly to large accounts of all kinds. And in pursuing that path, Microsoft is hardly alone. (See my column in this issue.)

The dollar volume of those sales definitely *won't* be small change for Microsoft's OEMs, but even worse than the loss of revenue, they say privately, will be the distance the move puts between Microsoft and the OEMs, distributors, dealers, and customers it has spent years cozying up to.

Throughout the PC business these days we see a trend of large hardware and software vendors beginning to sell their products outside their traditional distribution channels. Cynics claim it's just greed: the vendors are skimming the cream off the business by taking the big, profitable, and often easy sales for themselves. Those vendors, though, say that their traditional channels have often failed to understand and support complex products very well and are unskilled in selling to large customers—and thus bring little to the table when it comes to locking up big-account sales.

The debate rapidly descends into a vortex of claims and counterclaims, innuendo and insults. It's clear that the enmity stirred up by the recent moves of Microsoft and others draws on a long-simmering pot of ill feelings in these relationships. That makes rational discourse difficult.

But from the customer's perspective, the vendors' argument is certainly the more persuasive one.

As we move into an era of vastly more-complex computer systems, which are increasingly used to support the core functions of large companies, it's hard to imagine how those products can be sold and supported only by third parties. The retail channel's distributors and resellers are clearly unable to bring adequate skills to the sales, installation, optimization, and continuing support of CPUs and connectivity products that function on the minicomputer level.

A number of the larger value-added resellers, or VARs—that intermediate-level class of dealers who have traditionally specialized in selling, installing, customizing, and supporting complex products—possess the technical savvy to install and probably to support many of the new generation of PC products.

But can they sell them?

CRITICAL FUNCTIONS

It's becoming clear that customers are really the largest force behind vendors' moves into selling outside traditional channels. Corporate customers are unwilling to rely on anything less than continuing involvement by the makers of products themselves when those products are going to be used for critical "lifeline" functions in a company. We can handle it, they say, when new word processing software turns out to have some bugs in mail-merging. We *can't* handle it when our network operating system turns out to have some bugs in hard-disk mirroring or in defining remote access privileges.

So, say the vendors, if they're going to have to be there anyway—and if the sale is made largely on the basis of the vendor's reputation rather than a dealer's salesmanship—why shouldn't they sell outside traditional channels?

It is very expensive to mount a direct-sales-and-support operation for technical products. Such Microsoft OEM customers for *LAN Manager* as 3Com and Novell probably couldn't afford to mount a nationwide direct-sales operation, and so must rely on distributors and dealers.

But a Microsoft—or a Lotus, or a Compaq—could afford to establish that kind of operation. And, some say, they'll find over the next few years they *must* do so, as they introduce products that can't be squeezed through traditional channels.

OUT IN FRONT

LAN Manager is in some ways an odd choice to lead this parade.

It's easy to see how Lotus decided *Notes* would be sold directly, or how Compaq may decide the Systempro line *has* to be sold directly. But since *LAN Manager* will be sold to non-OEM customers as a relatively incomplete core product, with support only for Microsoft's JetBEUI transport-layer protocol, Microsoft is still going to have to rely on its new partners to add value, developing the software for such critical additional protocols as TCP/IP.

Lawyers like to say that bad cases make bad law, by which they mean that case law based on appellate decisions in atypical cases can mask the underlying principles and confuse those who must interpret those decisions.

That's the case in Microsoft's decision to expand direct corporate sales beyond its network-product OEMs. Some OEMs, such as 3Com, seem to have read the decision correctly and are shifting focus to extending the reach of *LAN Manager* networks. Others, such as Compaq, may be caught on the horns of a dilemma: deeply committed to *LAN Manager*, they now find themselves outflanked by their supplier, who proposes to "sell around" them, reducing both their profits and control of their customer base.

For network customers, though, there is nothing ambiguous about Microsoft's decision. We'll have a wider range of variations and sources of *LAN Manager*, which will make for harder choices but better results. ■

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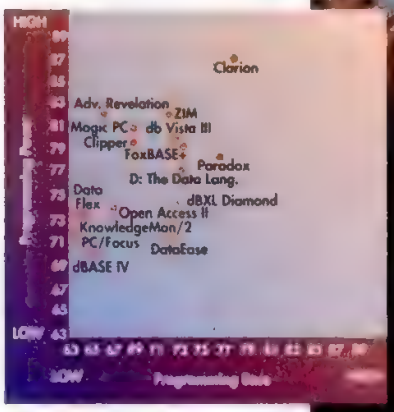

Here's what American corporations in a PC Week survey thought of the power and ease of use of Professional Developer vs. competitors. Any questions?

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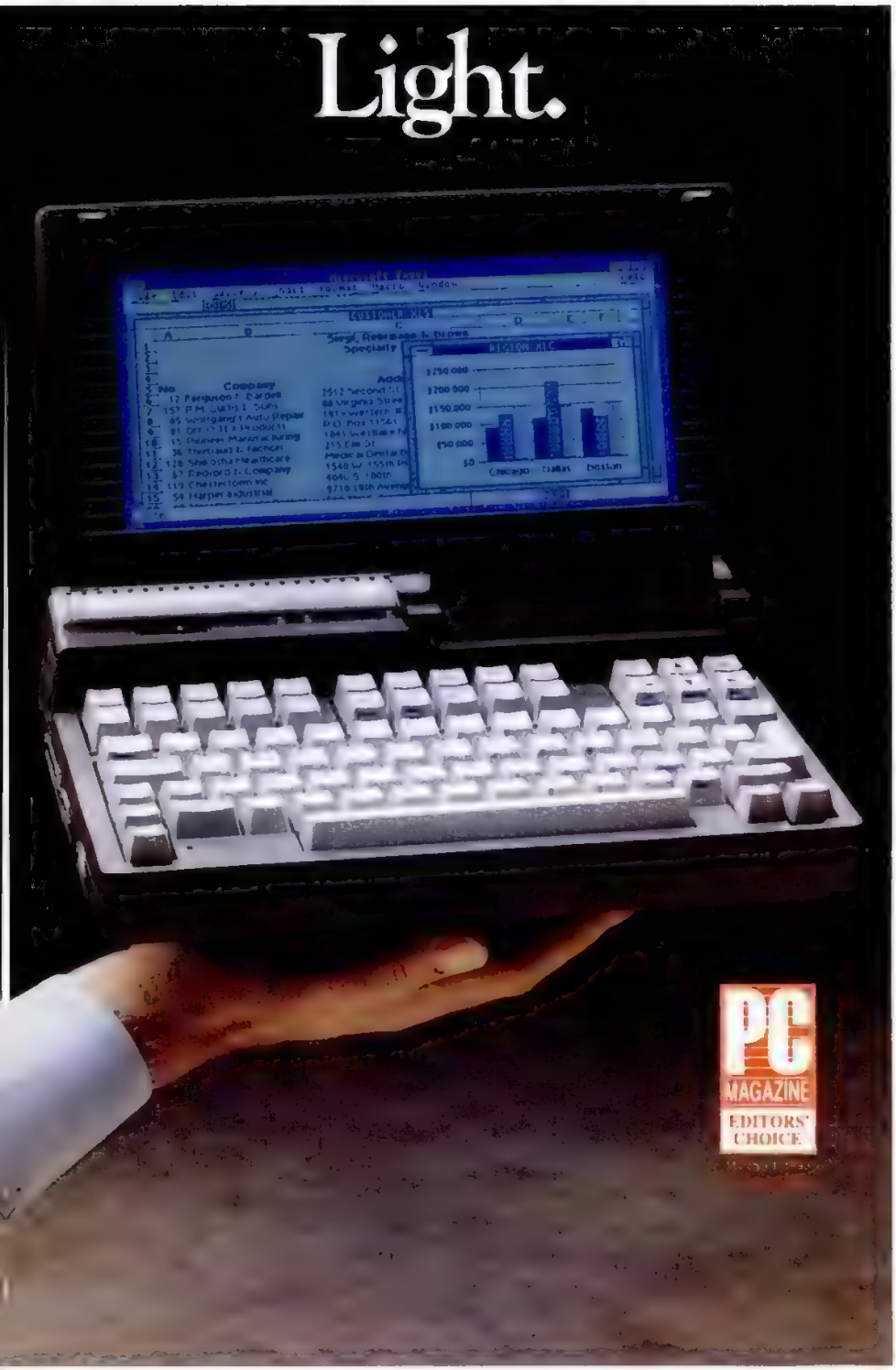

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Not only do you get a superb display, you get superb performance as well. Like standard AT-compatible desktop PCs, the Models 25 and 45 operate with a 12 MHz 80286 microprocessor for quick and powerful processing. You also get a 20 MB or 40 MB internal hard disk drive; an internal 3.5" floppy disk drive; 640K of RAM, expandable to 3.64 MB; an AT-style keyboard with full-size, full-travel keys; and an internal battery.

As with the Model 12, an intelligent power management system turns off the screen and hard disk drive during periods of inactivity to extend battery life, allowing you to use the laptop longer.

Considering all these features and the performance and versatility they deliver, why would you ever need a desktop PC? **For the names of the dealers nearest you, call 1-800-527-3500.**

CIRCLE 353 ON READER SERVICE CARD

TEXAS INSTRUMENTS

Neon Sculpture by
Lili Lakich
Los Angeles, California

Seagate's Technology

THE FINE ART OF DISC DRIVES

To the naked eye, disc drives haven't changed much in the past few years. While the visible aspects have remained the same, the parts you can't see have improved dramatically. What used to be megabytes are now gigabytes. And Seagate is at the forefront of this technological revolution.

We've not only increased capacities, but we've found ways to make drives faster and more reliable. For example, Zone Bit Recording™ is a recording technique that permits higher capacity and faster average data transfer rates than conventional recording methods. Our straight-arm actuator has 60% less mass than most other designs, giving our Wren™ and Sabre™ families lightning-quick access performance. And by increasing spindle rotation 50% to 5400 RPM, we've significantly increased the transfer rate and reduced the latency in our 1.5 GB Elite™ drive.

As a result of these and other technological improvements, Seagate now offers drives from 20 MB to 2.5 GB in the widest range of form factors and interfaces imaginable, for almost every conceivable application. And we're not through yet.

Like the artist who spends years perfecting his craft, Seagate has spent the past decade mastering the fine art of disc drives. To get a first-hand look at the state-of-the-art, contact your authorized Seagate distributor, or call Seagate directly: 800-468-DISC, or 408-438-6550.

Seagate

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the days and even the time that users can log on to the network. Forced periodic password changes require each user to change his code name at selected time intervals.

Novell has many other excellent tools for network managers. Even with the well-designed menus in its Syscon utility, exploring the wealth of options takes a lot of time. However, you will find that it's time well spent, since once you're familiar with these programs you can do everything necessary to manage the network effectively.

When used properly, electronic mail becomes a tremendous asset to any company. While the *NetWare* packages do not include e-mail, Novell does offer an important service that third-party e-mail systems can use: the Message Handling Service (MHS). MHS is a piece of software that runs on the server PC in the network and exchanges messages between e-mail and applications packages marketed by various third-party companies.

FACT FILE
EDITOR'S CHOICE

NetWare 386, Version 3.0
Novell Inc., 122 East 1700 South, Provo, UT 84606; (800) 453-1267, (801) 429-5900.
List Price: $7,995 (unlimited users).
Requires: 386 processor, 2.5MB RAM on server (640K RAM recommended on stations), DOS 3.0 or later.
In Short: The new standard for network operating systems. Simple installation, dynamic self-configuration, and virtually unlimited file systems capabilities provide companies with a robust network operating system.

CIRCLE 409 ON READER SERVICE CARD

FACT FILE
EDITOR'S CHOICE

Advanced NetWare 286, Version 2.15
Novell Inc., 122 East 1700 South, Provo, UT 84606; (800) 453-1267, (801) 429-5900.
List Price: $3,295 (100 users).
Requires: 286 or 386 processor, 2.5MB RAM on server (640K recommended on stations), DOS 2.0 or later.
In Short: Although it now plays second fiddle to *NetWare 386*, good old *Advanced NetWare 286* is still a powerful product for medium-size workgroups. In addition to being much less expensive than *NetWare 386*, *Advanced NetWare 286* is the most tried and trusted network operating system in the business.

CIRCLE 410 ON READER SERVICE CARD

NOVELL'S CASH COW

With the release of *NetWare 386*, many people have forgotten that *Advanced NetWare 286* is the source of much of Novell's yearly $400 million revenue. While the appearance of the 386 version means that the king of network operating systems slides down a notch to service medium-sized networks (up to 100 users), the disk mirroring and duplexing available through its SFT option provides those networks with added reliability.

Installing *Advanced NetWare 286* is no easy task. Value-added resellers have amassed years of experience configuring *Advanced NetWare 286* servers. Plan ahead to install all the network hardware you'll use in the near future, because just about any changes you make require another several hours to "regen" the operating system. On the workstation side, creating boot disks is not nearly as difficult.

Under *Advanced NetWare 286*, one computer acts as the server providing file and print services. *Advanced NetWare 286* is not a peer-to-peer operating system, so the workstations on the network cannot share their resources without adding third-party products. Novell bases all communications with the server on its own protocol, IPX/SPX. If you need NetBIOS service for applications like 3270 terminal emulation, Novell's emulator works well.

NetWare's biggest shortcoming is its print-spooling software. Luckily, printer enhancement programs are available to aid network printing by addressing the software's primary weaknesses: it is difficult to use, and as mentioned above, you cannot share workstation printers (see the article "Network Printing Without Pain" in this issue).

Overall though, *Advanced NetWare 286* is as good as ever. Organizations needing a fast, reliable, and secure network will be very happy with it. Don't let the difficult installation procedure scare you away. Your dealer can shield you from that.

NEW KING OF THE HILL

With *NetWare 386*, Novell provides the industry with a great platform for building client-server applications. Two features put *NetWare 386* in a class by itself: its increased capacity and its $7,995 price tag. By today's standards, *NetWare 386* is very fast, doesn't degrade under heavy processing loads, and provides huge amounts of storage. For tomorrow, it is a rich environment for the introduction of a new generation of applications.

Designed for use on the 486 as well as the 386 processors, *NetWare 386* is a true 32-bit network operating system. (In contrast, Microsoft's present release of *LAN Manager* running under OS/2 1.1 has only a 32-bit file system.) If *NetWare 386* detects the presence of a 486, it will take advantage of it.

NetWare 386 is a great platform for building client-server applications, but two features put it in a class by itself: its increased capacity and its $7,995 price tag.

Although it is tough to predict the hardware of the future, we think *NetWare 386*'s RAM and disk maximums will not be surpassed any time soon. In fact, outfitting a PC today with *NetWare*'s theoretical maximums is not possible: you would find other alternatives before you sat through a memory check of 4 gigabytes of RAM.

As with previous versions of *NetWare*, this system is memory-hungry, requiring 2MB RAM. Of course, its ability to address the 4GB RAM means that its appetite shouldn't pose a problem.

Novell has moved into the minicomputer arena with its new file system. It's fast, reliable, and efficient. By providing a maximum disk space of 32 terabytes (that's 32,000 gigabytes), *NetWare 386* can handle the data load of the largest companies. *NetWare 386* can service many disk I/O requests simultaneously and accommodate 4GB files by allowing volumes to span multiple drives. Currently, *NetWare 386* allows each server 100,000 open files and up to 250 users. Knowing that the 250-user limitation could be short-lived, Novell is making provisions for adding more users in subsequent releases.

The Multiple Name Spaces feature allows *NetWare 386* to handle files from different operating systems, thereby becoming a multioperating system server. *NetWare 386* associates different filenames for a single file that will be used by different systems. For example, a *Microsoft Excel* file used by both the DOS and Macintosh versions has two file entries when stored on the server.

Novell extended its file-salvaging feature with two options. One option automatically purges all deleted files; the other maintains all deleted files until *NetWare* runs out of disk space. As *NetWare* needs disk space it purges on a first-deleted basis; the system manager can purge all recoverable files at any time. *NetWare* preserves security by letting only a properly authorized user undelete a file. And Novell now does more than encrypt passwords on the server: it actually encrypts them on the wire, preventing network analyzers from reading data the workstation sends to the server.

Perhaps the most innovative feature of Novell's *NetWare 386* is Dynamic Resource Configuration, which not only optimizes directory caching and routing buffers, but does it on the fly.

Perhaps the most innovative feature of *NetWare 386* is Dynamic Resource Configuration. Both the system administrator and users benefit from this artificial-intelligence-type feature. *Advanced NetWare 286* requires the system manager to allocate specific amounts of memory for directory caching and routing buffers, and to down the server any time these values change. Not only can *NetWare 386* change these values with the server up, but the operating system itself determines the optimum values and corrects them on the fly.

As for the installation itself, you can get *NetWare 386* up and running faster than you can install *Microsoft Windows*—and with less hassle. To set up the server, the system administrator simply answers questions about the type of network adapter and hard disk being used. We installed the system and had users logged on in 15 minutes, excluding the time necessary for preparing the hard disk.

Novell provides companies moving from *Advanced NetWare 286* to *NetWare 386* with a smooth transition. If you have extra hard disk space available on another server, simply copy to it all the data on the server being upgraded. After installing *NetWare 386* you run the UPGRADE program, and it converts all of your *NetWare 286* system information, including passwords, user rights, and mappings, to the new format.

ENHANCING NETWARE 386

Third-party developers can add functionality to *NetWare 386* through programs called *NetWare* Loadable Modules (NLMs) that can reside in the server. NLMs include many kinds of applications ranging from database server modules to monitoring and administrative utilities. While NLMs offer great functionality, it is important to remember that they are running in the same machine as the file-server software. This means that NLMs have access to the kernel of *NetWare 386* and if something goes wrong, they could bring down the file server.

A package called *Programmer's Workbench* includes all the tools necessary to create distributed applications for *NetWare 386*. Programmers can use these tools to create DOS and OS/2-based workstation front ends for accessing the server applications. The package also includes a book that warns developers about the actions that could bring down the server; additionally, Novell holds classes for NLM system developers.

Programmer's Workbench comes with the *C Network Compiler/386*, which has all the same functions as the regular compiler but is specific to the 386 and to NLMs. Along with these compiler packages Novell includes *NetWare* Remote Procedural Calls for *NetWare 386* and the *NetWare* STREAMS specification.

The new NLM versions of the Print Server and Btrieve database engine provide added benefits. The print server now supports printers attached to local workstations and manages up to 16 printers on the network. This flexibility lets organizations do high-volume printing at more-convenient, more-secure locations. The *Btrieve* software, Novell's key-indexed record manager, is the back-end processor for the new client/server computing model and is optimized for the 386 (you can see its performance benefits in the article "Can LANs Beat Minis?" in this issue).

To keep just anyone from adding an NLM or server applications to the server, Novell includes the Secure Console option restricting this option to all but the system administrator. Another feature making the system manager's life easier is the new Workgroup Manager classification; as the name implies, this person has supervisory privileges for the users assigned to his workgroup.

UPCOMING UPDATES

Version 3.1 of *NetWare 386* should be available by the time you read this. Novell includes two other NLMs with Release 3.1. A variation of FCONSOLE, the Remote Management Facility gives an authorized workstation control of the server's screen and console. Version 3.1 will also include an NLM for Version 2.0 of the Appletalk Filing Protocol (AFP) so that Macs can use a *NetWare* server directly. Since both *NetWare 386* 3.1 and AFP 2.0 use the Unix STREAMS architecture, the data exchange won't use mid-level translation like the present Novell service for Macs.

Version 3.1 also adds two security enhancements: security auditing and encrypted backups. The former feature keeps a nonmodifiable audit trail of all security changes occurring on the server. And as *NetWare* backs up files over the network, the data is sent and stored in encrypted form and only unencrypted when it gets back to the server following a restore.

Another interesting upgrade announced by Novell is the *NetWare Naming Service*. Right now, when you want to use resources on multiple servers in a *NetWare* network, you must log on to each server. The multiple log-on actions can be automated, but it's a lot of work for network administrators. The *NetWare Naming Service*, available for *Advanced NetWare 286* and *NetWare 386* in mid-1990, gives users a simple way to access multiple *NetWare* servers and offers network managers centralized administration. *NetWare Naming Service* uses the concept of *domains*, a set of servers grouped into a logical unit. By logging in to a domain, users log in to multiple servers transparently.

If you buy Version 3.0 of *NetWare 386*,

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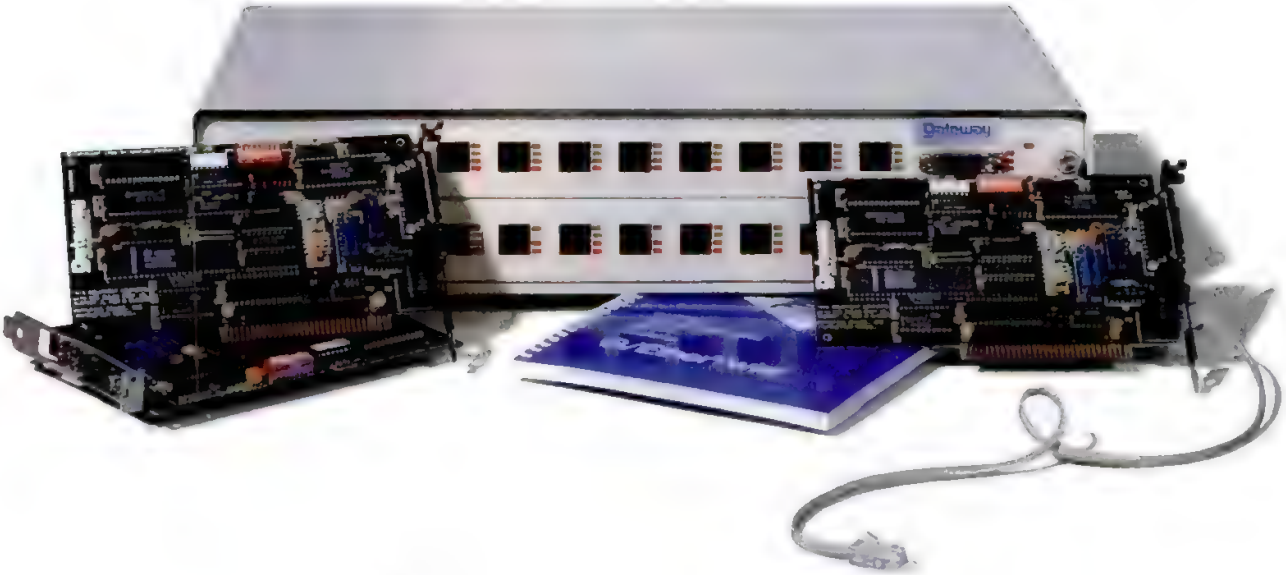

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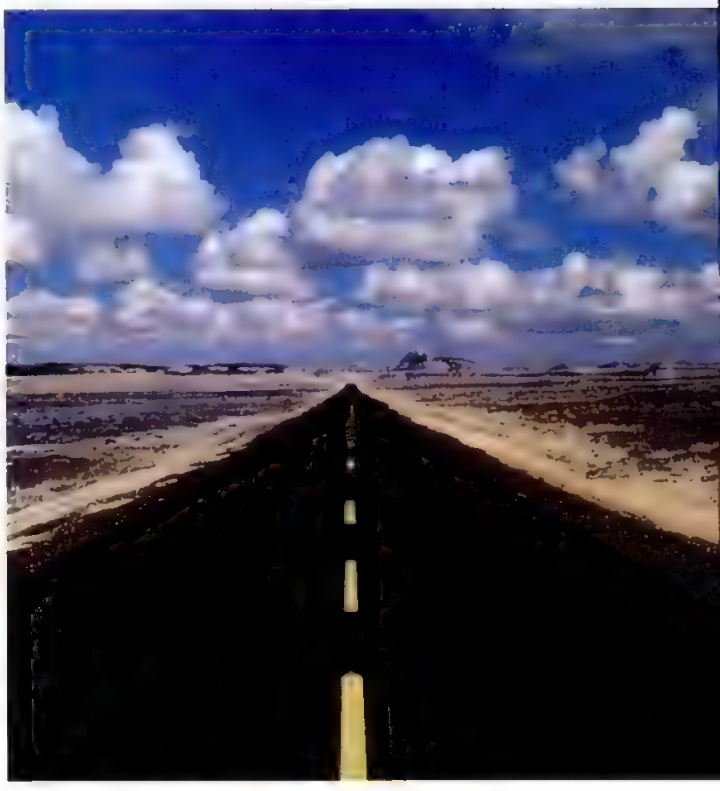
CIRCLE 146 ON READER SERVICE CARD

There are two ways to get into your programs.



The DOS way.

DOS . . . the one way, no passing, twisted, backed-up path you use every day to get into your programs.

If you've had it with directories, backslashes, typos, and mumbo-jumbo program names, then get behind the wheel of new Direct Access™ 5.0. And zip into programs in just a keystroke.

Turn on your computer and up pops the Direct Access menu screen. Simply press the key that matches the program you want (like your word processor, spreadsheet, or database) and bang—you're in. Or use your mouse if you want. No extra typing. No mistakes. No complications. Entry so fast, you'd better wear a seat belt.

Direct Access also gives you password protection, so unauthorized users can't get into your applications.

The Direct Access way.

Quick and quiet virus detection that checks your applications for dangerous computer viruses. And newly enhanced usage tracking that shows how much time you're spending in your programs. It even searches your hard disk for programs and automatically builds your menus for you. There's a special version just for networks, too.

Even the critics love Direct Access.

PC Magazine named Direct Access as the Editor's Choice for menuing software: "Whether you need a menu system for a company-wide installation or yourself, Direct Access is the way to go."

When you consider everything Direct Access gives you for just $99.00, it's no surprise it's the number one menu software in the world.

Isn't it time you got into your programs without a roadmap and compass? Write or call Delta Technology International today for more information, or look for Direct Access at your software dealer.

CIRCLE 256 ON READER SERVICE CARD

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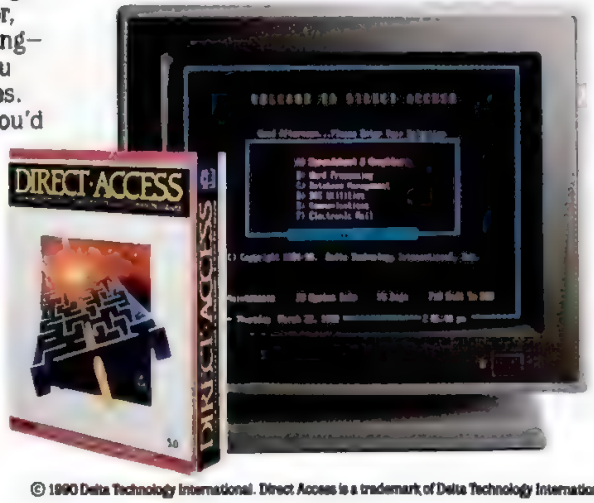
(800-325-0471 in Canada)



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you receive a free upgrade to Version 3.1 and the *NetWare Naming Service*, Integrated Macintosh Support, and Remote Management Facility NLMs. After the release of 3.1, these will cost $1,995 each.

NetWare 386 is everything users and application developers could ask for in a network operating system. The file system is fast, reliable, and spacious; system maintenance is simple; and the OS is expandable in terms of both the number of users and future hardware. It also gives programmers the platform and tools to create next-generation server applications. While $7,995 may seem high, you get minicomputer performance at much less than minicomputer pricing.

Nexos

by M. Keith Thompson

DSC Communications Corp. designs and manufactures products for the telecommunications industry, with an emphasis on digital switching, data transmission, and private network systems. *Nexos*, a new product from the company's Local Network Division, is a modular LAN operating system designed specifically for the 386 processor. It's easy to learn and use, and it can coexist with *NetWare* LANs. The product supports Ethernet, ARCnet, and Token-Ring topologies with a wealth of network adapters. And when you consider the price—$3,295 for up to 255 users—it's hard not to like this cost-effective performer.

DSC recognizes the value of interoperating with other LAN software. With a *Nexos* LAN adapter or other supported card, you can simultaneously log on to *Nexos* servers and Novell servers on the same cable.

One of the biggest advantages *Nexos* offers over its competitors is its ease of installation. The server configuration program presents a windowed menu of system setup parameters. These menus lead you through choices for topology, memory, disk, and tape drive features. Even though you are creating a unique 80386 protected-mode operating system, the installation takes just a few minutes.

The workstation installation is similarly easy. You create a bootable disk containing a specific batch file, then select the name of the network adapter you want to use from a menu, and the software does the work for you. You can easily make batch files that execute after a user logs on to the server to give each station individualized drive mapping and services.

Nexos supports diskless workstations better than *NetWare* does. With *Nexos*, you can make a different customized AUTOEXEC.BAT file for each station—it's even easy to do. However, it doesn't support diskless operation on all brands of adapter cards.

Nexos also allows up to two users to log on to the server via modem and operate as if they were on the LAN itself. Most other network operating systems require additional software for this feature.

Logically designed menus go a long way toward making system administration quick and easy. *Nexos* displays all of the information you would expect from a server operating system, including network status, logged-on users, file attributes, and all security options.

Extensive help also makes life on the network less problematic for users. A memory-resident help utility consumes about 29K RAM; if you can't afford that much RAM, each program has aid available with the /? parameter.

SECURING AND STRUCTURING YOUR DATA

Security is always a big issue in any network operating system, and *Nexos* is up to the challenge. *Nexos* controls security by granting privileges to various groups of users and by assigning passwords both to groups and to individuals. The system even goes beyond normal directory security and extends rights assignments to the file level.

DSC avoids using expensive disk-mirroring methods, implementing fault tolerance by logging each transaction to the built-in tape drive as it happens. You can specify how this option works; typically, the operating system will write changes made in a file out to the tape. This doesn't give a true transaction log but does make it easy to update a crashed file. In the event of a system crash, the network manager simply restores the file server structure from the logged tapes.

The *Nexos* operating system contains its own file structure. The directory is an index containing the name of each stored file with pointers to the file's location. The file structure makes it easy for a database program to retrieve a specified record within a database.

To compete with Microsoft's *SQL Server*, *Nexos* includes a database server based on DataFlex. *Nexos* runs slightly modified DataFlex applications quickly and efficiently by transferring only the requested data (rather than the whole database) across the LAN to the client station, thus reducing network traffic.

On the whole, the system gives decent but not lightning-fast performance. On our ten-station load test, running on DSC's 33-MHz 386-based MicroServer with zero wait states, *Nexos* ranked an uninspired third from the bottom.

One potentially annoying restriction is *Nexos*'s inability to support a large variety of hard disk controllers. At this time, a *Nexos* server can't use a SCSI controller, although the operating system will support common Western Digital models. Since the server can use only one hard disk controller, all the disk drives must be the same type.

ONE-STOP SHOPPING

DSC offers one-stop shopping for all your network needs. In addition to *Nexos* and the MicroServer, the company offers a complete line of network adapters and communications products. Network interface boards include 4-megabit-per-second Token-Ring cards, and ISA and Micro Channel versions of ARCnet and Ethernet cards; TCP/IP communications software and 5250 and SNA gateways are also available.

The company provides a complement of service and support options, on-site help within 8 hours, a mail-in service plan, and

FACT FILE

***Nexos*, Version 2.7**
DSC Communications Corp., P.O. Box 110940, Campbell, CA 95011; (800) BUY-NEXOS.
List Price: Nexos 286-8 (for 8 users), $495; Nexos 286-24 (for 24 users), $995, Nexos 386-8 (for 8 users), $1,995; Nexos 386-255 (for 255 users), $3,295.
Requires: For 286-specific software: 640K RAM on server, 256K RAM and DOS 2.0 or later on stations. For 386-specific software: 2MB RAM on 386-based server, 256K RAM and DOS 2.0 or later on stations.
In Short: Coexistence with *NetWare*, ease of use, and a toll-free support line make this operating system a good choice. Developers should also explore using this environment for applications.

CIRCLE 411 ON READER SERVICE CARD

My network keeps cutting

Now what?

Of all the crazy problems that come across your desk each day, a network adapter board failure has to rank near the top.

First of all, it shouldn't happen. Adapter boards should be reliable hardware and the bugs should have been worked out of them long ago. Second of all, like most network problems, adapter board failures cause a disproportionate amount of pain.

Why is the new VP suddenly off the network? Where do I start?

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off the new guys in finance.

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There are 3Com adapter boards available for the IBM® PC, PS/2® and compatibles, the Apple® Macintosh® and 10BASE-T versions for the IBMs. And more software has been written to run on 3Com adapters than any other. So compatibility shouldn't be a problem.

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CIRCLE 293 ON READER SERVICE CARD

a toll-free technical support number open weekdays from 7:00 A.M. to 5:00 P.M. Pacific time.

In the U.S., DSC delivers its networking products through value-added resellers and LAN specialists. Companies fidgety about getting into the network act will be grateful that DSC's VARs are well trained and have access to the company's systems engineers.

DSC's *Nexos* is filled with an abundance of features that meet most networking needs. Although it may not be as tried and proven as *NetWare*, *Nexos* has handy extras like transaction logging, a database-server programming environment, and a healthy compatability path from Novell's operating systems to its own.

POWERserve

by M. Keith Thompson

Performance Technology, founded in 1985 by the minds behind Datapoint Corp.'s ARCnet, offers a fast multitasking network operating system, *POWERserve*. On our benchmark tests, the $2,795-per-server package was the only product to challenge *NetWare 386*. Running on the ALR PowerCache 4 486-based Micro Channel system, its scores on our ten-station load test were just a notch below *NetWare*'s on the EISA version of that machine. It even bested *NetWare 386*'s scores on the Compaq Systempro and NetFrame machines.

At a glance, the workstation software resembles CBIS's DOS-based peer-to-peer system, *Network-OS*. The reason for the similarity is that Performance Technology licensed the source code from CBIS; some changes have been made to the system, though. For instance, Performance Technology has rewritten the underlying routines for faster operation and added some menus for easier installation. The server software offers optimized file-access routines.

Using NetBIOS, *POWERserve* can communicate with OS/2-, Unix-, and Xenix-based networks, as well as with third-party gateways, communications servers, and other products. The software uses the Server Message Block transmission protocol, which allows compatibility with many other networks—*LAN Manager* and *3+Open LAN Manager* among them. By including a popular, top-notch electronic mail program, *cc:Mail*, Performance Technology also allows interoperability with other LANs using *cc:Mail* and MHS.

PUTTING POWER ON YOUR NETWORK

Installing *POWERserve* is simple and quick, requiring only that you answer some easy questions about your configuration. *POWERserve* also needs at least 2MB of expanded memory, although Performance Technology recommends 4MB to 8MB for best performance. On 80286-based computers, this must be true EMS; 386 machines can use Quarterdeck Office Systems' *QEMM-386* to turn extended memory into expanded memory. *POWERserve* supports disk sizes up to 512MB (anything larger than that must be split into logical drives) and 255 users.

POWERserve includes a variety of network management tools. The server's console screen provides an easy-to-understand view of network statistics on performance and activity, active workstations, and cache queue status.

An optional utility called *Navigate* is a favorite at PC LAN Labs. The product is invaluable for helping both users and administrators become more familiar with the new concepts of networking, providing an easy way to find and manage files and subdirectories on all of the LAN's servers and drives. Through sliding windows, it maneuvers you around the various servers, printers, volumes, and files.

In addition to its dedicated multitasking operating system, Performance Technology markets *POWERlan*, a peer-to-peer network operating system. Companies who may want to combine two such systems benefit from the fact that both *POWERlan* and *POWERserve* workstations run the same software; the network administrator needn't make users work with two different programs to log on to two different networks.

Performance Technology markets a variety of other network-related products. *POWERmirror* adds system fault tolerance to any SMB or NetBIOS setup through disk drive mirroring. *POWERbridge* bridges LANs with dissimilar topologies using the SMB protocols. Other products include a complete line of network cards as well as tape backup hardware and software.

With a strong network of resellers across the country and each reseller trained to install and support all Performance Technology products, the company has a real winner with *POWERserve*. Excellent performance, easy installation, and the inclusion of *cc:Mail* make *POWERserve* one powerful contender.

PC MAGAZINE FACT FILE

***POWERserve*, Version 1.3**
Performance Technology, 800 Lincoln Center, 7800 IH 10 West, San Antonio, TX 78230; (800) 825-LANS, (512) 349-2000.
List Price: $1,995 (255 users); Performance Pack, including *cc:Mail*, *Navigate*, and *POWERserve*, $2,795.
Requires: 286 or 386 processor, 2MB expanded memory in the server; DOS 3.1 or later on stations.
In Short: A fast dedicated network operating system that installs easily. True SMB support allows it to coexist with all SMB-based LANs. Includes *cc:Mail* electronic mail software, a nice extra touch.

CIRCLE 412 ON READER SERVICE CARD

3+Open LAN Manager

by M. Keith Thompson

With the most functionality of all the *LAN Manager* flavors, 3Com's *3+Open LAN Manager* still manages to come in at a reasonable price: $3,495 for unlimited users. The system operates under OS/2, providing you with the multitasking operating environment you need for reliable service, and cleanly avoiding the problems inherent in DOS-based systems with their makeshift methods of handling concurrent tasks.

Keep in mind that the version of *LAN Manager* that 3Com uses is 1.1, not 2.0. The *3+Open LAN Manager* package contains ten comprehensive manuals providing all the necessary information to bring the server to life. Particularly good is the installation and setup guide, which spells out every detail of the process in 80 pages. While this may seem like a ton of paper, technically oriented network managers will be glad the information is available. Any user could appreciate the manual's extensive use of flow charts, screen diagrams, and step-by-step instructions that lead you through the installation and management of OS/2 and the network.

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Installation is fairly simple, but it requires careful thought about the security and protocol options you want on your network. Don't jump into this area without due consideration, or you could wind up installing the server and workstation software all over again when you discover that your first choices were ineffective in your organization.

3+Open LAN Manager operates under either one of two security arrangements. User-level security assigns a password to resources such as disk drives, I/O ports, or anything you designate with a network name; this method is typical of Microsoft-based networks and is extremely flexible. The second, called share-level security, is like *NetWare*'s arrangement: each user has membership in one or more groups, and the access rights and security restrictions of the group determine the individual rights.

You'll also have to decide which protocol you want to use over the network. 3Com products typically use the Xerox Network Systems (XNS) protocol to transport and receive data across the LAN. XNS is widely supported, and network devices such as bridges and routers from many different companies use it. IBM, however, uses the Data Link Control (DLC) protocol within its Token-Ring architecture. To ensure compatibility with IBM installations, *3+Open LAN Manager* includes the DLC protocol as an installation option.

Recognizing that interoperability is the wave of the future, 3Com also added Demand Protocol Architecture (DPA) to its product. This allows *3+Open LAN Manager* to support today's popular protocols—XNS, DLC, and NBP—as well as future protocols. With DPA, *3+Open LAN Manager* loads and unloads protocol stacks as needed for each data transfer.

FACT FILE

***3+Open LAN Manager*, Version 1.1**
3Com Corp., 3165 Kifer Rd., Santa Clara, CA 95052; (800) NET-3COM, (408) 562-6400
List Price: $1,695 (10 users), $3,495 (unlimited users).
Requires: 386 processor, 4MB RAM on server; 3MB on OS/2 1.2 station, or 640K on DOS station.
In Short: A proven product from a company with a lot of networking experience, *3+Open* quickly meets most networking needs and adds the extras for interoperability. Servers, network adapters, and good support and service make 3Com a one-stop-shopping network company.

CIRCLE 413 ON READER SERVICE CARD

THE NAME GAME

Named Pipes form an important part of the *3+Open* scheme. Named Pipes provide functionality similar to NetBIOS, but this system is more sophisticated and much easier for programmers to implement. Unlike NetBIOS, which was developed as a short-term solution and became a standard by default, Named Pipes were designed from the ground up for internetwork communications.

Named Pipes let a program on one node communicate with programs running on other nodes. Although PC-based LANs can do this today using NetBIOS services, Named Pipes are much faster because the session between nodes is maintained through multiple transactions of data instead of through individually addressed blocks of data.

The power of Named Pipes is appealing, but unfortunately the success of this system isn't assured. Not only is it competing with NetBIOS, it is also up against IBM's own sophisticated universal communications scheme, Advanced Program-to-Program Communications (APPC).

3Com's server, the 3Server/500, offers a reasonable amount of bang for the buck. While it is not the fastest server around (at 20 MHz), the 3S/500 has a built-in 16-bit Ethernet card and a special connector for a second processor (although the company has not yet made any announcement about that piece's availability). The standard configuration includes 8MB RAM, a 250MB tape backup, and a 320MB hard disk. The 3S/500 has a unique feature: triple-ported RAM that allows the CPU, the built-in network adapters (LocalTalk and Ethernet), and the disk controller to access memory at the same time. While in theory this increases throughput, our tests put the 3S/500 only in the middle of the pack as a network server.

3Com is committed to providing connectivity solutions well into the future. As a *LAN Manager* OEM, 3Com is in a position to ensure that *3+Open LAN Manager* will soon benefit from all the enhancements Version 2.0 offers. As more companies license and market *LAN Manager* 2.0 under their own name, look to 3Com to lead the way by providing the extras needed for complete connectivity. This company has been around for some time and has learned the value of being able to communicate with other environments.

VINES

by Paul Ferrill

A strong platform for micro-to-mainframe communications and field-proven in many large installations, Banyan Systems' $5,995 *VINES*, Version 4.0, now provides a number of new features that the competition only talks about delivering.

The most envied and soon-to-be-emulated feature of *VINES* is its StreetTalk naming service, a way of naming resources and users located on various servers and nodes across the network. The *VINES* software lets you assign a resource name in the form "Item@Group@Organization" and a user password. Every server maintains and updates a universal Access Rights List containing the StreetTalk names of the resources and the users allowed access to each. The beauty of the system is that the administrator doesn't have to log onto each station and configure resources and user rights; all the action takes place at the server. The technique makes it very easy to establish a high level of resource security.

***VINES' StreetTalk* is unique in that it allows a user to access gateway services, mail systems, print queues, and fax and host gateways with a single password.**

Version 4.0 of *VINES* introduces a new feature called StreetTalk Directory Assistance (STDA). STDA is particularly useful for extremely large LANs with multiple servers. It allows users to find and access network resources faster by replicating directory information on the various network servers about users, lists, printers, file volumes, and other services.

StreetTalk is unique in that it allows a user to access gateway services, mail sys-

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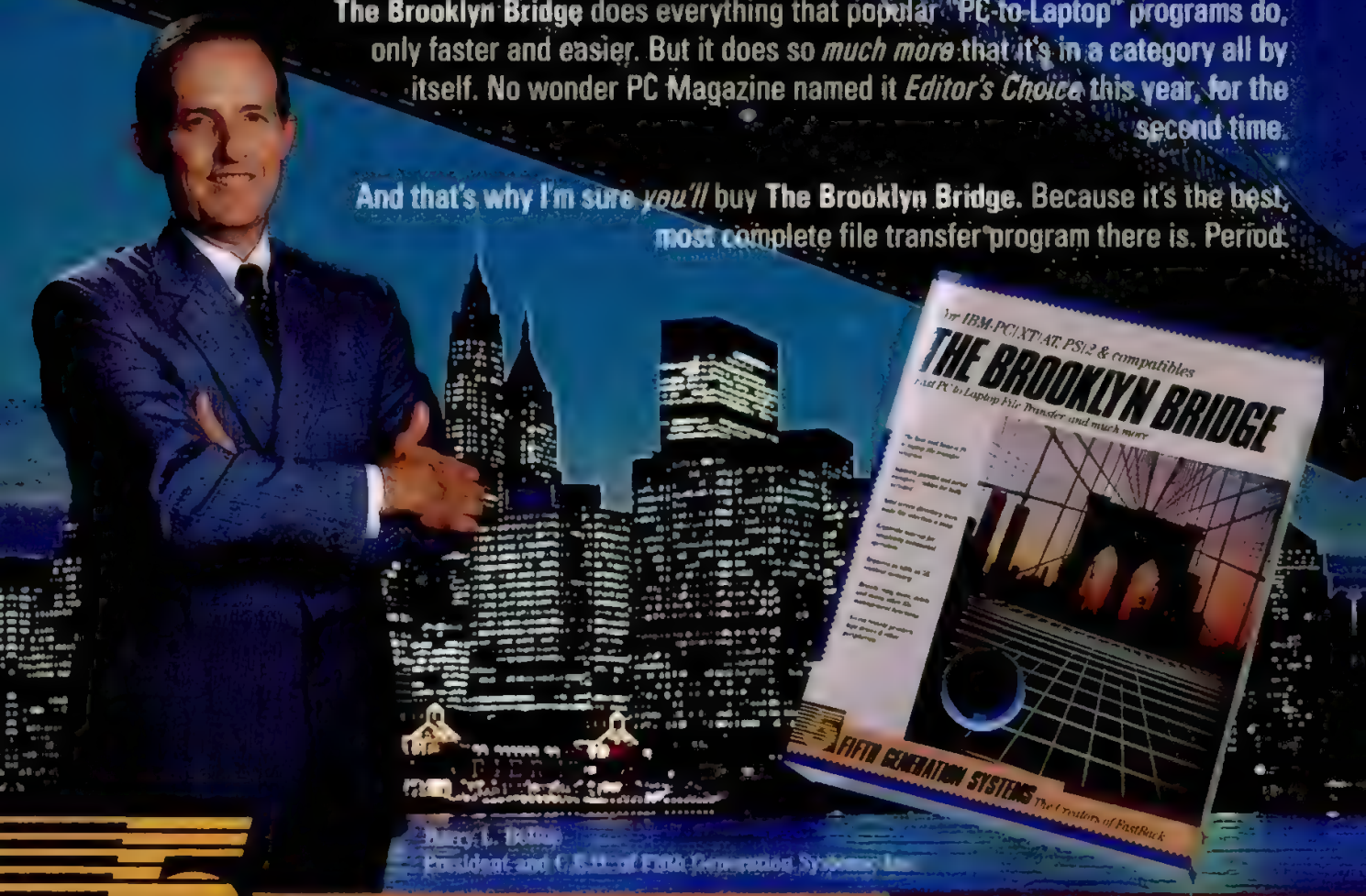

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tems, print queues, and fax and host gateways with a single password. The global naming services that will be available in future releases from Novell and Microsoft will require users to have a different password for each service and function.

VINES has addressed the business sector's growing need for multilingual computer capability with the first distributed naming service that supports multiple languages at the same time. StreetTalk can, for instance, allow the same status message to be transmitted automatically and simultaneously to French and English speakers in their respective languages. The product also fully supports international time, and it accounts for different time zones and daylight savings time. The multilingual service is based on the ISO Standard 8859/1 for international characters.

Power-hungry users will appreciate the product's upcoming ability to support up to eight separate 386 and 486 processors running in a single machine. Unfortunately, the multiprocessor version of *VINES* wasn't available in time for our benchmark testing.

A RANGE OF CHOICES

Version 4.0 comes in a variety of flavors to suit your needs: you can choose *VINES/386 Micro Channel*, *VINES/386*, or *VINES/286*. The underlying operating system for *VINES/386* is AT&T Unix System V, Version 3.2.1. The 386 products can hold their own, but a 286 processor gets a heavy workout running the Unix-derived operating system used in *VINES/286*. In fact, the 286 product is really targeted at small or remote workgroups.

As for the client software, it requires 115K RAM when loaded without EMS. This number can go down to as little as 20K with the use of a product like Quarterdeck Office Systems' *QEMM-386*. Additionally, OS/2 support was announced in February and should be available by the third quarter of this year.

You can just about pick the hardware platform you want to use for your *VINES* server. Banyan's top-of-the-line tower-style Corporate Network Server boasts an 80386 or 80486 processor, up to 24MB RAM, 2.2GB of disk space, 30 serial lines, and as many as four LAN adapter cards. Banyan's Desktop Network Server, also targeted for workgroup use, is a 68000-based machine housed in an AT-style box, with up to 5MB RAM and a 500MB hard disk. Additionally, any Intel-based machine that runs AT&T Unix is a candidate to be a *VINES* server.

VINES supports a host of LAN boards as well, including Intel, Interlan, ProNET-10, SMC PS110, ARCnet, AT&T StarLAN, Racal-Interlan (formerly Micom) NI5210S, and IBM Token-Ring adapters. Banyan has also announced support for adapters meeting the Network Driver Interface Specification (NDIS).

An expanded line of IBM connectivity support accompanies this release of *VINES*. For example, the 3174 Emulation/Token-Ring adapter allows a *VINES* server to communicate with an SNA host over a Token-Ring network through a 3174 or 3745/372X controller. This feature enables users to employ a single IBM Token-Ring network for both PC-to-host and PC-to-server traffic and provides greater throughput when you are accessing the host.

Additional Token-Ring support is provided through Source-Level Routing. This allows *VINES* servers or clients to communicate across IBM Token-Ring bridges to remote *VINES* servers. Another feature is Token-Ring bridge emulation, which puts the bridge function inside the Banyan server and eliminates the need for dedicated PCs to operate as Token-Ring gateways—with some added load on the server's processor.

Although *VINES* doesn't run away with any speed awards (it ranked next to last on our ten-station load test), the latest version goes far toward enhancing an already super product. The integration with Token-Ring networks and the wide choice of gateway options provide a versatile net-

FACT FILE

***VINES*, Version 4.0**
Banyan Systems Inc., 115 Flanders Rd., Westboro, MA 01581; (508) 898-1000.
List Price: $5,995 (unlimited users).
Requires: Banyan CNS, DTS, or BNS server or 286/386-based PC as server; 640K RAM and DOS 2.0 or later on stations.
In Short: A versatile LAN operating system with multiple options for connecting to other hosts and services. With EMS memory, the RAM limitation disappears. The multilingual capability provides a solution for companies with foreign offices.

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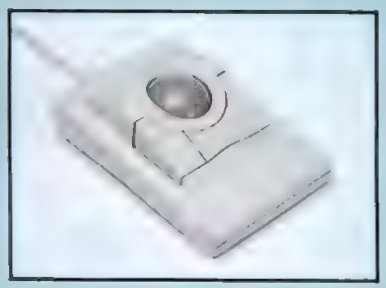

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work operating system for the corporate environment. With the addition of multilingual support, Banyan is positioning itself to provide network services to the world.

VMS Services for PCs

by Paul Ferrill

The latest version of Digital Equipment Corp.'s *VMS Services for PCs* outperforms its predecessor by 2.5 times on the PC LAN Labs benchmark tests. At least, that's what the company's information flier says. In reality, our testing shows that in some cases the gain is even more significant, although the product still comes in behind its competition. Nevertheless, the improved speed and other enhancements make the PCLAN/Server 3100 with *VMS Services for PCs*, Version 3.0, a much better package than the one we reviewed at the beginning of the year (see "PC Meets VAX," January 16, 1990).

One thing that has not changed is the price of a complete package. For $12,500, you get a system that includes a PC-LAN/Server 3100 with 8MB RAM, a 104MB hard disk and 95MB tape drive, Ethernet controller, and four serial ports, plus VT320 terminal console, VMS operating system, *DECnet-VAX Network Software*, and *VMS Services for PCs*, among other attractions.

As for the enhancements, DEC rewrote a major part of the server software to improve the way it handles files. The disk service is essentially a virtual disk on the host machine—in our case, the PC-LAN/Server 3100. DEC has developed new algorithms for memory management and has utilized file caching to improve throughput significantly.

The file service function stores individual files on the server disk in the native server format; this means that a conversion must take place from a PC format to a VMS format. To speed up this function, DEC has employed caching for opened files and for those that are opened and closed frequently. In the latter instance, the server leaves each file open for a fixed amount of time and closes it if it is not accessed within that period. These changes have enabled DEC to realize an 80 percent improvement in throughput.

Note that *VMS Services for PCs* will run on any of DEC's VAX computers. This allows any company with a VAX system already installed to get a network up and running with a minimum of new hardware. It also allows a level of integration between the PCs and central computers that would not be available through a standalone PC network.

REVAMPING THE CLIENT SOFTWARE

Another area of change has been in the client or PC software. DEC converted the old code, written in C, to assembly language; this alone accounts for a 60 to 80 percent improvement in speed. Additionally, the company incorporated expanded and extended memory management support, increasing the available memory in the PC from 440K to 520K. The software uses the latest Microsoft redirector, which ensures compatibility with other Microsoft-based PC LANs.

Additional products included with the DOS client set it apart from other vendors' offerings in terms of the basic package's functionality. The DOS client comes with a full-function DEC VT320 terminal emulation package, an *X-Windows* server program, *PCMail* (a basic service for sending simple messages where attachments are not required), and *All-In-1 Mail for MS-DOS* (an X.400 mail service). *All-In-1* allows you to store and forward mail and binary-file attachments, and it offers support of corporate Distributed Directory Services.

The DOS client configuration program has been upgraded to be more menu-driv-

FACT FILE

***VMS Services for PCs*, Version 3.0**
Digital Equipment Corp., 30 Porter Rd., Littleton, MA 01460; (800) DIGITAL.
List Price: PCLAN/Server 3100 with 8MB RAM, 104MB hard disk, 95MB tape drive, Ethernet controller, four serial ports, VT320 terminal console, VMS operating system, *DECnet-VAX Network Software*, *VMS Services for PCs*, *PCMail*, *SEDT* editor, VT320 terminal emulation, $12,500. For server: Ethernet card, mouse, LK250 (DEC) keyboard with IBM AT cable, *DECnet*/PCSA client software, $845. For each station: Ethernet adapter card, *DECnet*/PCSA client for DOS, $495. PCLANmark package for 8-user system, $16,900; for 16-user system, $19,500.
Requires: 640K RAM on stations, DEPCA or Ethernet adapter card.
In Short: An vast improvement over the previous version. New pricing and integrated packages are aimed at the first-time network buyer, making this the best way for a DEC site to network PCs.

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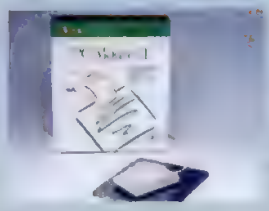
The Optical Advantage



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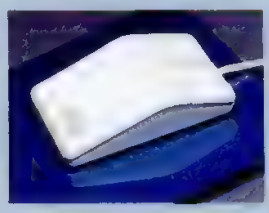

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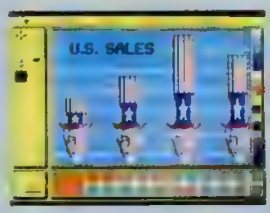

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en, which increases its effectiveness in helping you set up the workstation for whatever hardware is installed. This can include Ethernet cards from other vendors such as 3Com; the 3Com 3C503 and 3C523 boards are supported using the Network Driver Interface Specification (NDIS).

DECnet for OS/2 is a new product. This system provides OS/2 clients with complete DECnet functionality on the LAN, including the basic file, print, and application sharing, as well as full integration of OS/2-based PCs into the larger network. The package is based on the newest DECnet OSI (Open Systems Interconnect) protocol; this means that OS/2 machines can connect directly to larger DEC minis and mainframes, as well as to the LAN server products.

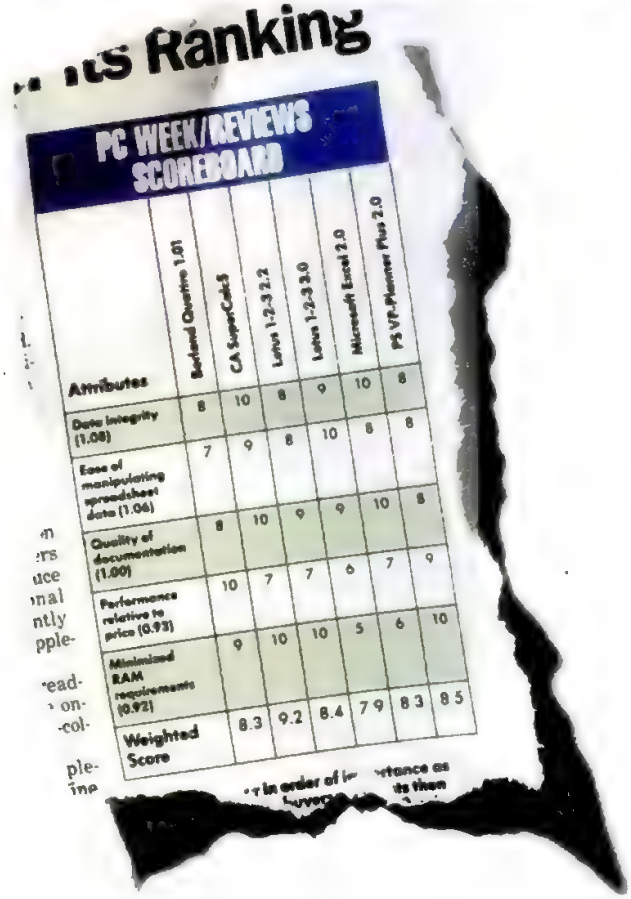
NEW PRODUCTS AND PROGRAMS

In the hardware arena, DEC has moved the tape drive that used to be external to the PCLAN/Server 3100 inside the cabinet. The model TZ30 tape drive has a capacity of 95MB and is fully compatible with the older TK50 drive. DEC has also announced a new hard disk for the 3100, the model RZ56, an external 665MB device. Up to three of these boxes can be daisy-chained to the server to provide almost 2GB of disk storage.

In an effort to get new customers to try out its LAN products, DEC has announced a money-back-guarantee trial program. Until June 30, 1990, you can have a 60-day trial of any of three complete PC integration packages: hardware and software for 8 or 16 users, priced at $16,900 and $19,500, respectively, and a software-only package for 8 users at $7,500. The first two packages include on-site installation; all come with up to 4 hours of telephone support for more than 30 popular networked PC applications.

While the system's performance still doesn't come up to that of other standalone networks, it has been greatly improved from its previous release. DEC has addressed some of the major problems with the earlier version, like the amount of RAM available on the PC and a complicated installation procedure, and other features have been attractively enhanced. As the company is continually upgrading its product, look for announcements in the future regarding *DECnet*'s operation across all the major PC lines. ■

Perhaps The Best Way To Choose A Spreadsheet Is By The Numbers.



PC WEEK/REVIEWS SCOREBOARD

Attributes	Borland Quattro 1.01	CA SuperCalc5	Lotus 1-2-3 2.2	Lotus 1-2-3 3.0	Microsoft Excel 2.0	PS VP-Planner Plus 2.0
Data integrity (1.08)	8	10	8	9	10	8
Ease of manipulating spreadsheet data (1.06)	7	9	8	10	8	8
Quality of documentation (1.00)	8	10	9	9	10	8
Performance relative to price (0.93)	10	7	7	6	7	9
Minimized RAM requirements (0.92)	9	10	10	5	6	10
Weighted Score	8.3	9.2	8.4	7.9	8.3	8.5

In a spreadsheet world filled with personal opinions, misleading claims, and advertising hype, you may want to consider what an objective third party has to say.

Like *PC Week,* who recently conducted a comparison of all the top spreadsheets and found SuperCalc®5 to be the best.

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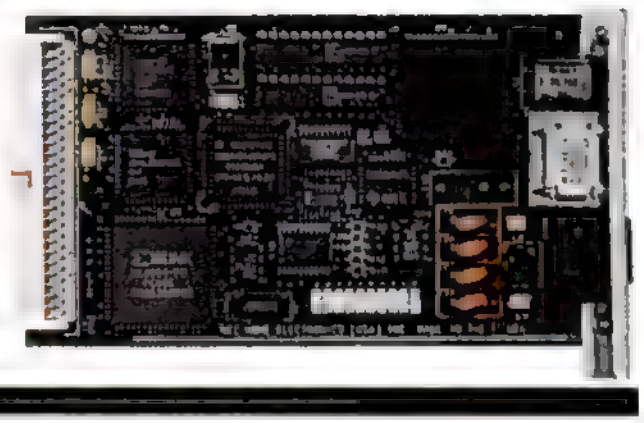

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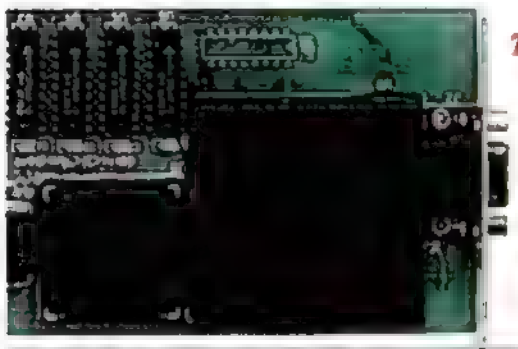

Token Ring adapter

connectivity

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options

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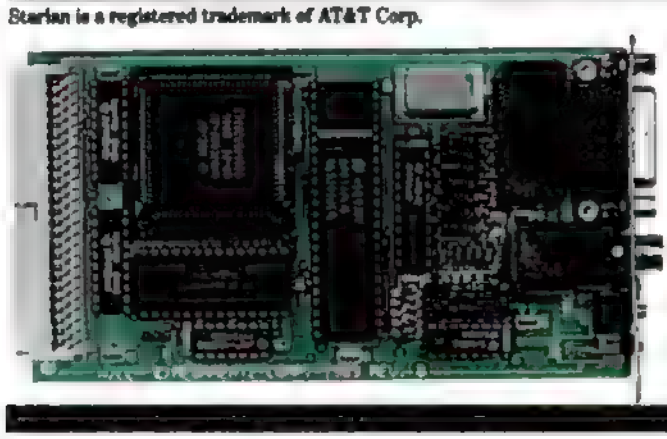

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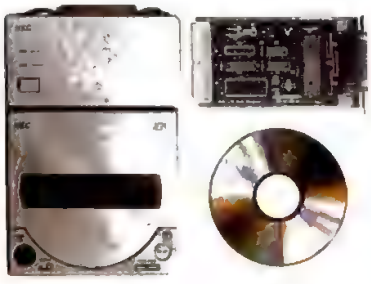

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CIRCLE 335 ON READER SERVICE CARD

NEC

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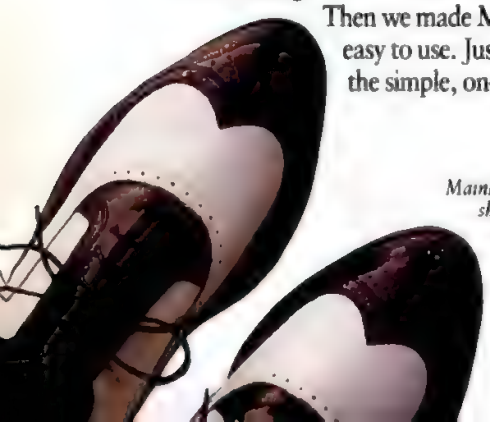
THE WAY A NETWORK SHOULD WORK.



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*MainLan Starter Pack includes network software, cables and 4 mbps hardware for connecting two PCs for $499 suggested retail price. MainLan Expansion Pack for adding one PC is $199.

System requirements: IBM® PC, XT or compatible. DOS 3.0 or higher. Network software requires from 50 to 85K, depending on configuration.

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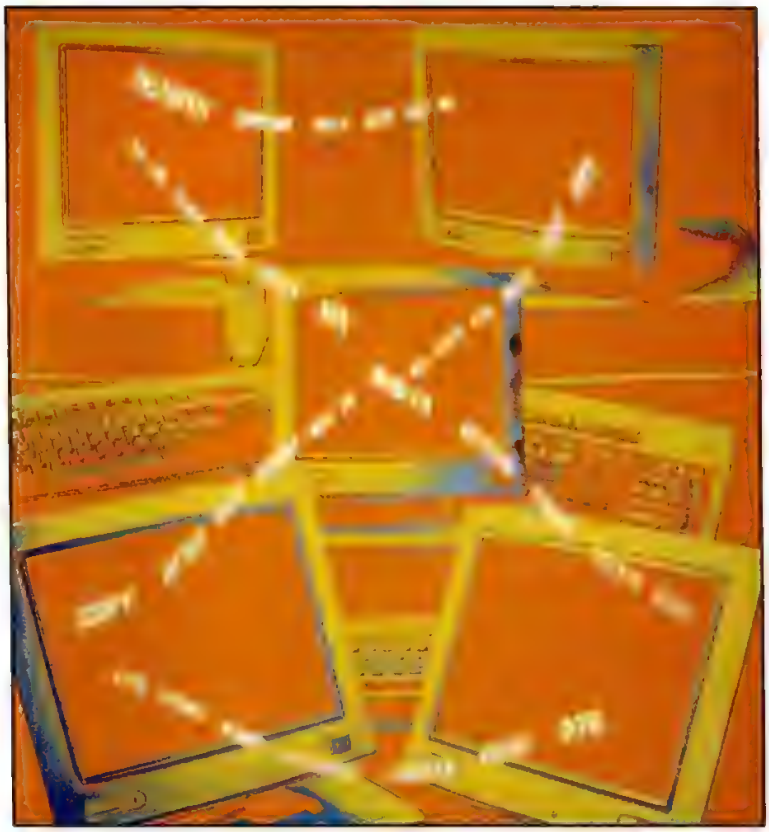
CIRCLE 230 ON READER SERVICE CARD

COMDEX Booth #3148

Making Do With DOS

If your networking needs don't stretch far beyond 12 users, a DOS-based peer-to-peer LAN with no dedicated server will be your most cost-effective solution.



PHOTOGRAPHIC ILLUSTRATION BILL LONGCORE

BY FRANK J. DERFLER, JR.

Some LANs run a multitasking operating system like Unix, VMS, or proprietary code on the file server; others simply run DOS. It's these DOS-based, or peer-to-peer, LANs that give you an economy their multitasking cousins can't match, particularly in small installations. A network set up to share printers and hard disks among three or four PCs should cost less than $200 per node. A LAN with a multitasking operating system, on the other hand, usually costs over $1,000 per node. It's easy to see why: just think of the expense of the dedicated server and the cost

THE LAN SURVIVAL GUIDE

of the operating system itself.

PCs running under DOS-based LANs can make their individual resources available to the network while simultaneously running normal applications. But when your PC acts as a server and donates a resource, you have less RAM for your application, and that application runs slower than when the network software is not loaded.

AFFORDABLE STANDARDS

Many companies used to package DOS-based LAN systems with adapter boards that used nonstandard wiring, signaling, and access control schemes. They justified the decision on the grounds that this approach costs less. But the prices of adapters meeting the IEEE 802.3 Ethernet standards and the IEEE 802.5 Token-Ring standards have dropped in the last 12 months, more companies have entered the market, and more chip sets have become available. Ethernet boards, for example, have gone down in price from $400 to just over $300, and you can get significant reductions for quantity purchases. And $250 ARCnet adapters are also common; while the ARCnet cable and signaling scheme doesn't match the IEEE standard, it is widely supported in the industry.

Because standard LAN adapters—802.3 Ethernet, Token-Ring, and ARCnet—are affordable and guarantee future support alternatives, very few organizations will find a compelling reason to buy nonstandard LAN adapter hardware. All of the products evaluated here support adapters (often remarketed from other companies) that meet these standards.

Using fast but nonstandard session- and transport-layer software is another practice that has been common in low-priced DOS-based LANs. The problem is that if the session- and transport-layer programs don't meet some industry standard like SPX/IPX or NetBIOS, the special services available to you, such as gateways and across-the-LAN remote control, will be severely limited. You

NONSTANDARD OPTIONS FOR LAN BARGAIN HUNTERS

by Kimberly Maxwell

The DOS-based LAN operating systems evaluated in this article can bridge to larger networks because the companies that market them adhere to standard IEEE or ARCnet interface specifications. *MainLan* and *PromiseLock/PromiseLAN*, DOS-based LAN products from US Sage and Moses Computers, don't use these standards, but both are interesting and relatively low-cost alternatives.

Each has full capabilities for exchanging files, sharing printers, and allowing multiple stations simultaneous access to the same data files with or without a dedicated server. Both require unique cabling or adapter cards.

The $499 *MainLan* starter kit includes two 4-megabit-per-second adapter cards, cables, and software. Micro Channel adapters are available, and additional nodes are $199 each. The package is easy to install and comes with clearly referenced documentation.

MainLan requires up to 70K per station for full file-server capabilities, but you can adjust the RAM usage depending on the requirements of the station and the network. For instance, on stations that don't make drives available to the network, the memory requirement can be reduced by 30K. You can also eliminate menus and other features to save memory.

The product incorporates a nicely designed e-mail package and a security system that locks away an entire disk or directory and opens it only in response to a password. It supports NetBIOS and has built-in IBM PC LAN facilities so that you can run third-party multiuser software. It doesn't support diskless workstations, nor does it have a disk cache utility.

US Sage recently announced an IEEE-standard 802.3 Ethernet card. The new board, based on the company's own LAN interface chip, will be NetBIOS compatible and able to work with other NetBIOS-compatible operating systems and terminal emulators. Contact US Sage Inc., 2005 Tree Fork Ln., # 125, Longwood, FL 32750; (800) 999-6770, (407) 331-4400.

GOING TO THE PROMISELAN

At $154 per node, Moses Computers' network operating system can run over its own proprietary hardware. But the *PromiseLock* network operating system software and *PromiseLAN* NetBIOS software (which reside on the same disk) can also run with any other NetBIOS-compatible adapter card. *PromiseLAN* is also SMB-compatible, so you have the option to connect your Moses workstation or server to other SMB-compatible nodes.

Moses Computers' three hardware options are called Netcards. The line consists of the four-port Quad hub (sold as part of the $397 Star Starter Kit, which also includes a license for five nodes and documentation); the two-port Dual hub (two are included in the $347 Starter Chain Kit); and the $125 single-port Single adapter. Separate active hubs, like those used with ARCnet, are not needed because the multiple-port cards have them built in.

You can connect up to 16 PCs using Moses Computers' software and hardware with standard telephone wires in a star topology. If you use the software with another vendor's NetBIOS-compatible adapter cards, the software supports up to 255 workstations. Unfortunately, at this moment, there is no bridge software to connect *PromiseLAN* to larger networks using operating systems such as *NetWare* with its IPX/SPX protocols.

Software installation is menu driven, but operation and configuration happen at the DOS command line. The security system is a bit different from most networks. All shared resources on the network are automatically given passwords; if you don't know the password, tough luck—you don't get access to the resource.

Though the product lacks several features found in some more-popular systems (e-mail, disk caching, and a remote boot facility), it remains an intriguing alternative to some of the higher-priced options you'll find today. Contact Moses Computers, 15466 Los Gatos Blvd., #213, Los Gatos, CA 95032; (408) 358-1550. ■

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■ If you hate starting over because of math errors, you'll love PerFORM's automatic math and logical calculations.

■ Don't you hate forms that look like amateur night? With PerFORM, you can import logos and graphics, size them up and down, design in black and eight shades of gray. Or scan the best-looking form you use and trace over it electronically. Every form PerFORM prints looks professional.

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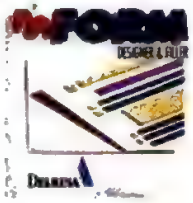

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really should think twice before buying a peer-to-peer network that doesn't offer NetBIOS compatibility.

The real advantage of using standard LAN adapters and transport-layer software is obvious: you get a growth path. Eventually, you can link networks within organizations.

PERFORMANCE VS. USABILITY

Of course, DOS-based servers don't retrieve files as fast as those that run multitasking operating systems. In fact, in responding to data requests from applications, DOS-based networks take up to five times as long as those with dedicated servers (their throughput rate is 200 kilobits per second versus 1 megabit per second). DOS-based LAN systems, however, are less complex to set up and manage than multitasking LANs.

How many stations can you set up on one of these systems? The question requires you to consider what it is you want to do on the LAN. Certain routines, such as database access, put a heavy load on a file server running DOS. PCs acting as network print servers also endure heavy loads—particularly if the printer has a small internal memory capacity and the server must handle many printer interrupts.

On the other hand, if people on the network use spreadsheets a great deal, they seldom need to access the file server. Other network applications (such as using a LAN SNA gateway to connect to a mainframe) don't touch the file server at all, so the performance of the server's operating system is moot. At major trade shows, Novell frequently demonstrates that its $7,000 *NetWare 386* can adequately carry the load provided by 200 workstations running a mix of applications.

In terms of cost, overhead and performance DOS-based LANs provide good value.

A single DOS-based server can generally handle up to 15 client stations running typical office applications. Of course, the ability to make several DOS-based machines contribute some file, print, or communications service to a network extends the potential number of happy LAN users you can connect and gives you more flexibility for planning.

COMMODITY PRODUCT

In many ways, DOS-based LAN software has become a commodity product. There is only so much you can do within the constraints of DOS, so the companies selling these packages must differentiate them by variations within a limited set of features and by price.

For example, many of the operating systems we reviewed include an electronic mail utility. Typically, these mail utilities rely on a single file server and bog down under the load of several dozen clients, but they work well for small LANs.

Among the programs' features, *10Net*'s built-in workgroup scheduling utility and *LANtastic*'s ability to share CD-ROM devices across the network stand out. The optional voice e-mail hardware available for *LANtastic* is an especially impressive adaptation of technology.

DOS-based LANs fill a niche clearly below the stratospheric multitasking LAN operating systems in terms of cost, overhead, and performance. But they do provide good value and, if you choose industry-standard components, the ability to lead you to the levels of performance and investment appropriate for your organization.

EDITOR'S CHOICE

▪LANtastic

Artisoft's *LANtastic* is our choice once again for its overall excellence in speed, features, and innovation. It maintains its low price and small RAM requirement in Version 3.0 but also offers much more. *LANtastic* integrates a new voice-chat feature that allows users to enjoy voice communications, while the new disk-caching capability brings *LANtastic*'s speed and performance far above the rest. People using the *LANtastic* system will be pleased with its ease of use and installation.

D-Link Systems' *LANsmart Operating System* deserves a very honorable mention. If you are looking for a small LAN that can run its own system concurrently with dedicated systems like Novell's *NetWare* or the TCP/IP protocol, *LANsmart* is your answer.

GV LAN OS

by Kimberly Maxwell

With *GV LAN OS*, you won't have to waste hours preparing your PCs to share disks, files, and peripherals. This package, from Grapevine LAN Products, boasts a quick installation that allows network users to enjoy a fully functional peer-to-peer operating system in a matter of moments.

Grapevine's software sells for $695 with a minimum five-user site license; the ARCnet card for each station costs $295. At an average price of $434 per node, *GV LAN OS* seems relatively expensive when compared with the other hardware/software packages on the market. While its simple installation and hassle-free operation help make up for its high price, you'd be better consoled if the system's file-transfer rates were faster: *GV LAN OS* was one of the slowest networks on our benchmark tests.

We installed the NetBIOS-compatible system on five Dell PCs in an ARCnet star topology with an active hub. A feature unique to the *GV LAN OS* ARCnet system is the ability to install the ARCnet network in a bus topology with coaxial cables. This approach eliminates the need for hubs in an eight-workstation environment (any more than eight and you need an

FACT FILE

***GV LAN OS*, Version 1.1**
Grapevine LAN Products Inc., 15323 NE 90th St., Redmond, WA 98052, (206) 869-2707
List Price: With five-user site license, $695; with unlimited site license, $1,395.
Requires: 77K to 119K RAM (depending on configuration), DOS 3.1 or later.
In Short: *GV LAN OS* is simple to install and requires no technical expertise to operate. If you don't mind the slow file transfers, it's a good starter LAN system.

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DOS-BASED LANs: SUMMARY OF FEATURES

Products listed in alphabetical order	GV LAN OS	Invisible Ethernet NET/30	LANsmart Operating System	LANtastic	Network-OS	PORT Lite
List price	5 users, $695, unlimited users, $1,395	$399 per node	$395	Starter kit (with 2 cards), $725, $349 per node	2 to 7 nodes, $160 each; 80 nodes, $1,480; 255 nodes $2,550	Starter LAN (with 2 car $995; softw only (5 use $695
SETUP						
RAM used in file server	119K	85K	70K	39K	120K extended	640K plus
RAM used in workstation	119K	65K	2K	13K	60K	64K
Extended or expanded memory	Expanded	Expanded	Extended	Expanded	Extended	Extended
Program can be unloaded from server RAM	■	❑	■	❑	❑	❑
Program can be unloaded from workstation	■	❑	■	❑	❑	❑
SOFTWARE						
Includes disk cache in server software	❑	❑	■	■	■	■
Displays print queue at workstations	■	■	❑	■	■	■
Offers customizable separator pages	❑	❑	■	■	❑	❑
Supports CD-ROM devices	■	❑	■	■	■	❑
Interfaces with IPX/SPX	❑	❑	■	❑	❑	❑
Supports remote-boot ROM	❑	■	■	■	■	■
Keeps error log	❑	❑	❑	■	■	■
Tracks resource usage	❑	■	■	■	❑	■
Displays active users	■	■	■	■	■	■
Displays available network resources	■	■	■	■	■	■
Has electronic mail feature	■	■	■	■	❑	■
Has chat feature	❑	❑	■	■	❑	❑
Has workgroup calendar	❑	❑	❑	❑	❑	❑
ADAPTER CARDS AVAILABLE FROM VENDOR						
802.3 thin Ethernet/AT bus	■	■	■	■	■	❑
802.3 thin Ethernet/MCA	■	■	■	❑	■	❑
802.3 thin Ethernet/EISA	■	❑	❑	❑	❑	❑
802.3 10Base T/AT bus	■	■	❑	❑	❑	❑
802.3 10Base T/MCA	■	■	❑	❑	❑	❑
802.3 10Base T/EISA	■	❑	❑	❑	❑	❑
Twisted-pair ARCnet/AT bus	■	❑	■	❑	❑	■
Twisted-pair ARCnet/MCA	■	❑	■	❑	❑	■
Twisted-pair ARCnet/EISA	■	❑	❑	❑	❑	❑
Coax ARCnet/AT Bus	■	❑	■	❑	❑	■
Coax ARCnet/MCA	■	❑	■	❑	❑	■
Coax ARCnet/EISA	■	❑	❑	❑	❑	❑
802.5 Token-Ring/AT bus	❑	❑	❑	❑	❑	■
802.5 Token-Ring/MCA	❑	❑	❑	❑	❑	■
802.5 Token-Ring/EISA	❑	❑	❑	❑	❑	❑
SUPPORT AND SECURITY						
Technical support	Free	Free	Free then $100/year (phone), $50/year (BBS)	Free for 30 days,	Free (discounts available)	$30 per cal
Toll-free telephone number	❑	❑	❑	❑	❑	❑
File password protection	■	❑	■	❑	❑	❑
File marking for execution only	❑	■	■	❑	❑	❑

Ⓔ—Editor's Choice ■—Yes ❑—No

active hub). With this type of network, proper terminators at each end of the LAN are essential.

Once you decide on the type of adapter (Ethernet cards are also available) and the topology for your network, you will find installation a breeze. On an ARCnet network, each board must have a unique address; a 20-page booklet packaged with your Grapevine adapter card assists you in setting it. Installing the software is simple: answer a few questions, assign user names and passwords, and modify your CONFIG.SYS file according to the manual's specifications.

Each *GV LAN OS* package contains a potentially confusing assortment of 12 to 15 floppy disks. You can expect to get software for both ARCnet and Ethernet configurations, and don't be surprised to find bridge software for specific broadband network adapters, as well.

The software gives you the ability to connect *GV LAN OS* with other networks. One set of floppy disks allows you to connect a zero-slot LAN (a network of PCs communicating through serial ports without network adapters) to your *GV LAN OS* network. This scheme is useful for connecting a laptop or a diskless

10Net Plus	TOPS Network Bundle for DOS
$195 per node	$249 per node; 10 pack, $995; FlashTalk card, $239
80K	85K
55K Both	65K Extended
■	■
■	■
■	❑
■	■
■	❑
■	■
■	❑
■	■
■	❑
■	❑
■	❑
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■	■
❑	❑
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❑	❑
❑	❑
❑	❑
❑	❑
❑	❑
❑	❑
❑	❑
❑	❑
❑	❑
Free	Free
■	❑
■	❑
■	❑

workstation to your network without sacrificing performance.

EQUALITY FOR ALL

Grapevine boasts that all PCs on its peer-to-peer network are equal. Each workstation requires 119K RAM, but you can lower that amount by loading 64K into expanded memory, or by using only a portion of the operating-system software (minus nice but unnecessary extras such as e-mail) in your machines.

You can either use DOS commands to perform network functions or else follow a pull-down menu route. The DOS command line helps execute NetBIOS-compatible multiuser software. The pull-down menus are a simple alternative. In each window, there is a list of commands and a brief explanation of each one's function. If you have any trouble with the operating system's installation or operations, Grapevine offers free technical support.

GV LAN OS's features are the same as those found in most other network operating systems. Rather ordinary facilities exist for sending letters, memos, and files to others on the network, for sharing CD-ROM drives over the LAN, and for accessing data on any networked station using DOS commands. Missing are more-sophisticated features like a disk cache, a chat mode, and a workgroup calendar.

GV LAN OS's simple installation and operation make it appealing, but there is certainly room for improvement in its speed. While it can be a good entry-level network operating system for a company that lacks in-house technical experts, some of the missing features make a number of competing products better overall choices.

Invisible Ethernet NET/30

by Pamela Watson and Kimberly Maxwell

Invisible Software introduced its first low-cost LAN back in 1986. Since then, the company's operating-system software, *Invisible Ethernet NET/30*, has grown to include support for expanded memory, which can reduce the amount of required RAM in your server station from 80K to 13K, and in workstations from 60K to 3K.

The company markets the *NET/30* software in a couple of ways. The *Invisible Ethernet* network package we tested is priced at $399 per node and includes an industry-standard Ethernet board, coaxial cables, terminators, and *NET/30* and *NET/30 EMS* software. *NET/30 EMS* has the same features as *NET/30*, but it allows you to put the network software, device drivers, and applications such as *Ventura Publisher*, *DESQview*, or *Lotus 1-2-3* into expanded memory or shadow RAM.

Being a true peer-to-peer LAN operating system, *Invisible Ethernet NET/30* doesn't require a dedicated server; rather, it allows for multiple servers throughout the network.

You can also purchase a package called the *Invisible Network*, which comes with *NET/30* and *NET/30 EMS* software, twisted-pair cabling, and a card that uses its own proprietary cable and signaling system. Choose boards for PC, AT, or Micro Channel machines, ranging in price from $215 to $399 per node. The *Invisible Network* delivers the same expanded-memory support and NetBIOS compatibility as *Invisible Ethernet NET/30*.

The *NET/30* software contains features found in most competing systems: pop-up menus, help screens, remote boot, print spooling, security, and e-mail. The pop-up e-mail feature lets you send and receive mail without exiting your application program. The security system provides password protection and the ability to define user groups, and gives control over access to directories, printers, and

FACT FILE

***Invisible Ethernet NET/30*, Version 1.52s**
Invisible Software Inc., 1165 Chess Dr., Suite D, Foster City, CA 94404; (415) 570-5967.
List Price: $399 per node (includes Ethernet board). 25-foot cable, $20; 50-foot cable, $40; Ethernet terminator, $5.
Requires: 3K to 80K RAM (depending on configuration), DOS 3.1 or later.
In Short: An efficient and reliable peer-to-peer operating system, *Invisible Ethernet NET/30* is a low-cost connectivity solution for small offices looking for a LAN system that can use expanded memory.

CIRCLE 397 ON READER SERVICE CARD

BENCHMARK TESTS: DOS-BASED LAN OPERATING SYSTEMS

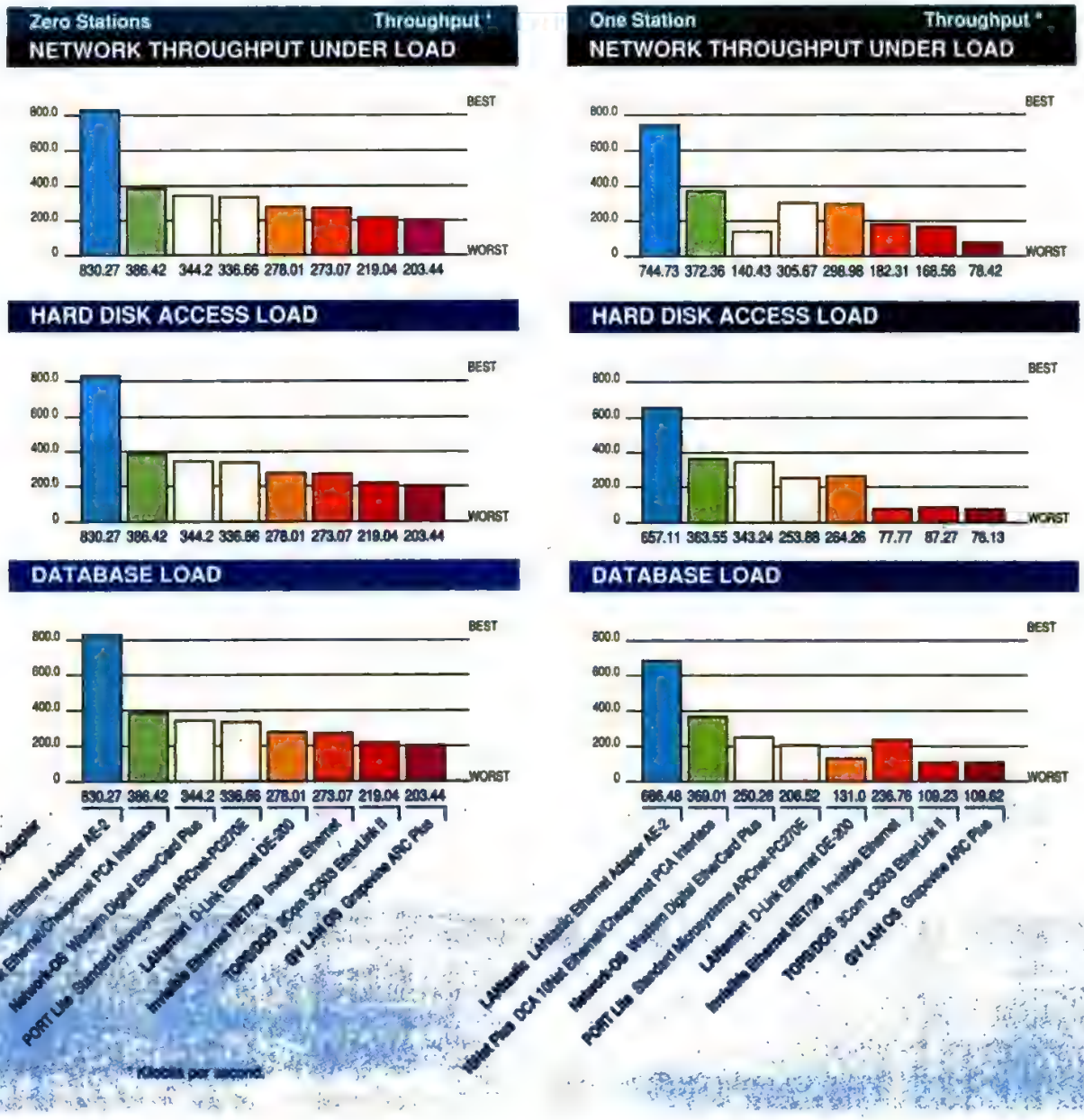
PC LABS

***LANtastic* blows away the DOS-based LAN competition in terms of performance. It doesn't have SMB compatibility and it doesn't have an ISO protocol stack, but it does have tightly written code that is closely linked to Artisoft's Ethernet hardware.**

The Network Throughput Under Load test loads network cards, media, and access protocols but places a small load on the server. While the timed station transfers files, load stations read and write 1-byte data files, creating a high volume of data packets and increased activity on the network.

The Hard Disk Access Load test heavily loads the hard disk and disk-caching system. Each load station randomly accesses its own 100K data file using 1K records, changing the data each time, while the timed station transfers files. This test is sensitive to the algorithms used in the cache scheme, the software's efficiency in handling the drive, and the speed of the drive and controller.

In the Database Load test, all stations share a 4MB data file and its index file during reading, locking, and writing tasks while the timed station transfers files. This test reflects the record-locking support of the system and the way it handles a number of random, simultaneous accesses to a common file.



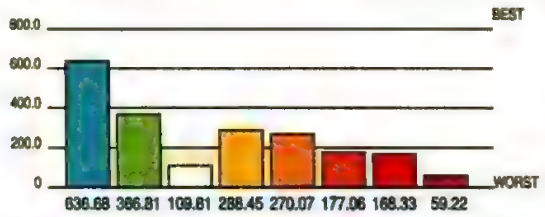
The PC LAN Labs benchmark tests are written in C and are independent of commercial software. Each load station operates at a rate many times that of a PC in a typical heavy-use environment (such as a data-entry operation). We have designed these tests so that a single station represents five to ten times the load of a user performing an interactive task (such as updating records) on a typical network.

The **Network Throughput Under Load, Hard Disk Access Load,** and **Database Load** benchmark tests each report the throughput recorded during the performance of a standardized task on the network. To obtain the figures shown here, we run a test program performing a sequential create, a sequential read, a sequential write, a random read, and a random write of a large file. The record sizes used in these activities systematically rotate among 16K, 4K, and 512 bytes. Usually a 1MB file is used, but this size may be adjusted for unusually fast or slow networks.

While the general test program is run, we load the network with specific programs for each of our three benchmark tests. The results shown represent the average throughput over a period of time sufficiently long to ensure consistency.

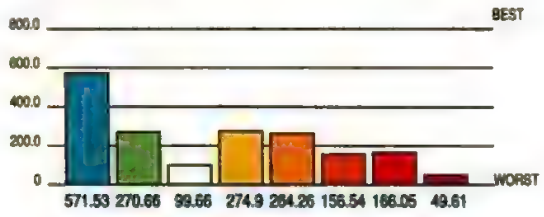
Two Stations — Throughput *

NETWORK THROUGHPUT UNDER LOAD

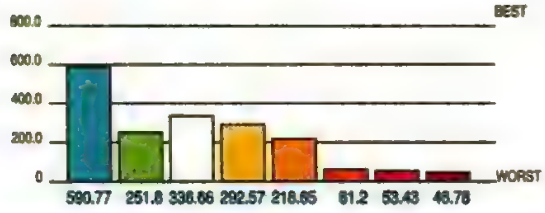


Three Stations — Throughput *

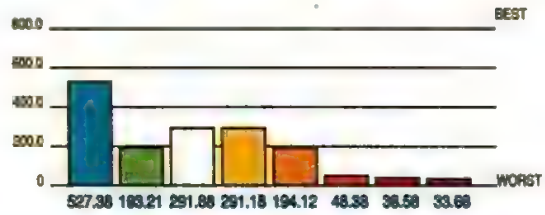
NETWORK THROUGHPUT UNDER LOAD



HARD DISK ACCESS LOAD

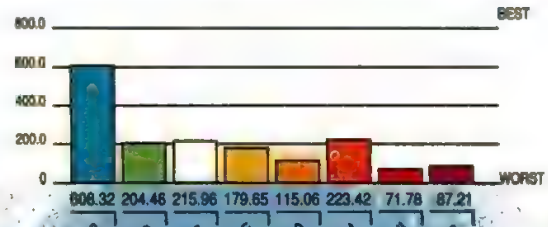


HARD DISK ACCESS LOAD



DATABASE LOAD

DATABASE LOAD



Software / Adapter

LANtastic LANtastic Ethernet Adapter AE-2
10Net Plus DCA 10Net Ethernet/Cheapernet PCA Interface
Network-OS Western Digital EtherCard Plus
PORT Lite Standard Microsystems ARCnet-PC270E
LANsmart D-Link Ethernet DE-200
Invisible Ethernet NET/30 Invisible Ethernet
TOPS/DOS 3Com 3C503 EtherLink II
GV LAN OS Grapevine ARC Plus

* Kilobits per second.

CONTINUES

COMPOSITE VIEW: DOS-BASED LAN OPERATING SYSTEMS

PC LABS

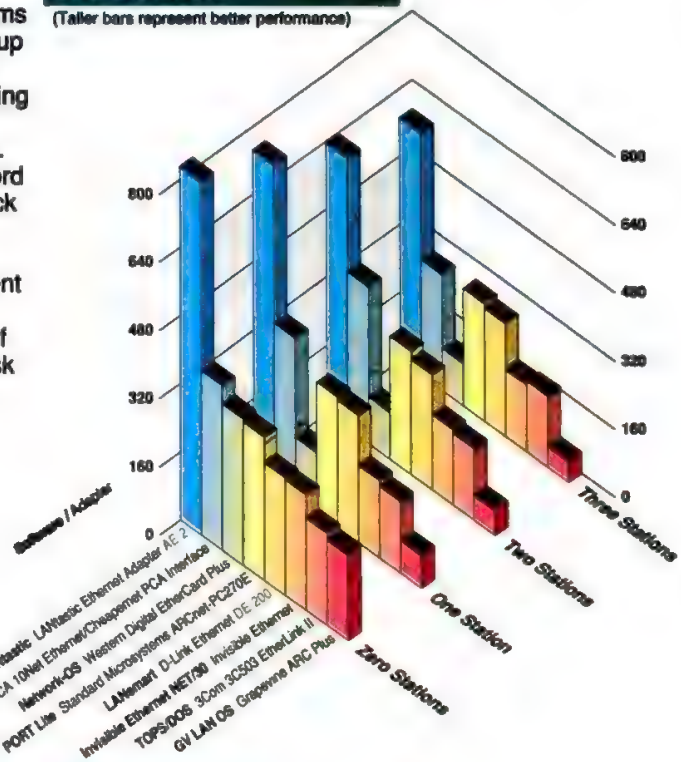
Our benchmark testing of DOS-based LAN operating systems reveals differences in system performance that don't show up when you use slow proprietary network adapters. We used network adapters marketed or recommended by the operating systems' own vendors.

LANtastic's superior performance dominated these tests. Further analysis revealed that *LANtastic* handles small-record requests much better than its competition. These small-block requests are typical of PC applications like database and accounting packages.

Additionally, Artisoft speeds performance with an excellent disk-caching utility, code written completely in assembly language, and very fast drivers for its adapters. The story of the slower-performing systems is just the opposite: poor disk caching, layers of big programs, and inefficient driver software.

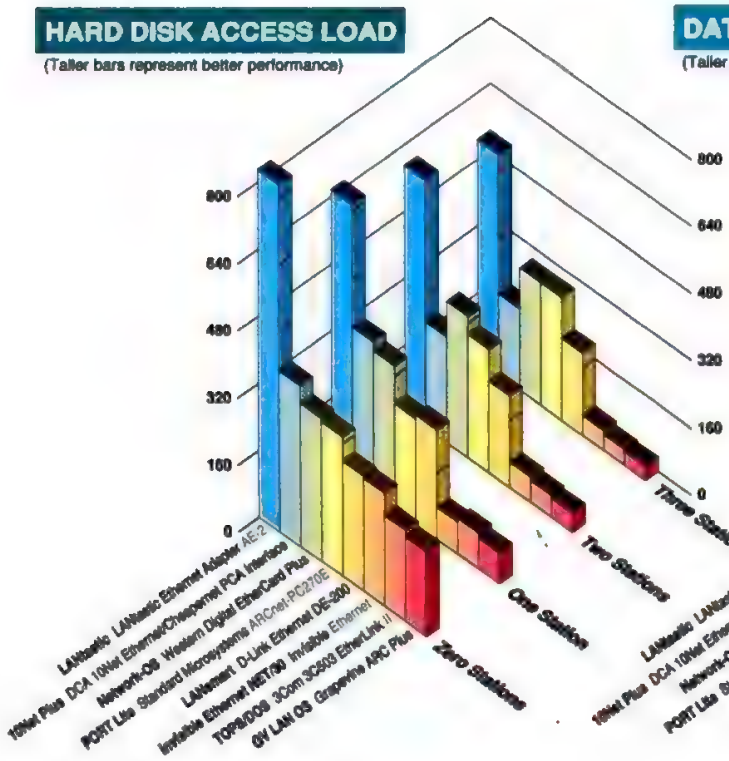
NETWORK THROUGHPUT UNDER LOAD

(Taller bars represent better performance)



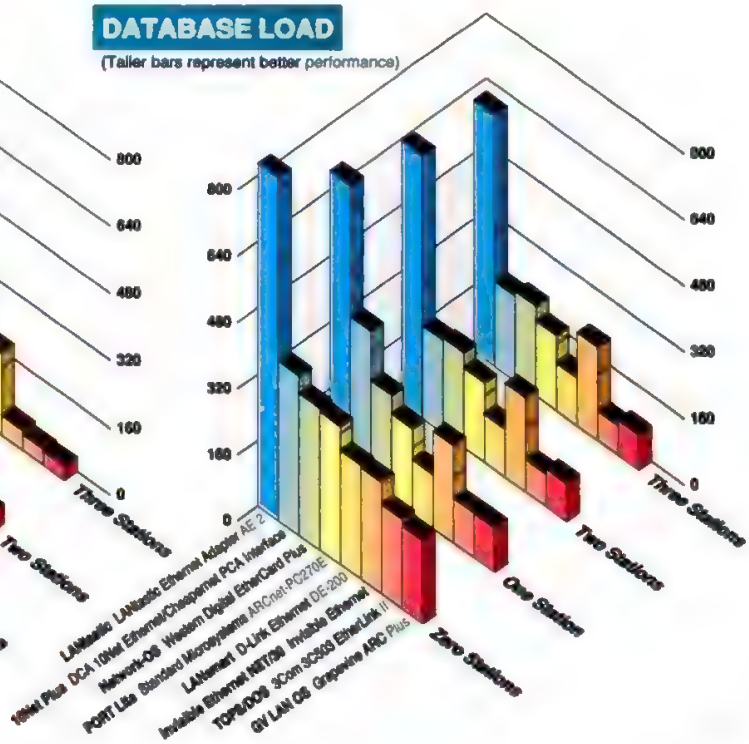
HARD DISK ACCESS LOAD

(Taller bars represent better performance)



DATABASE LOAD

(Taller bars represent better performance)



ENDS

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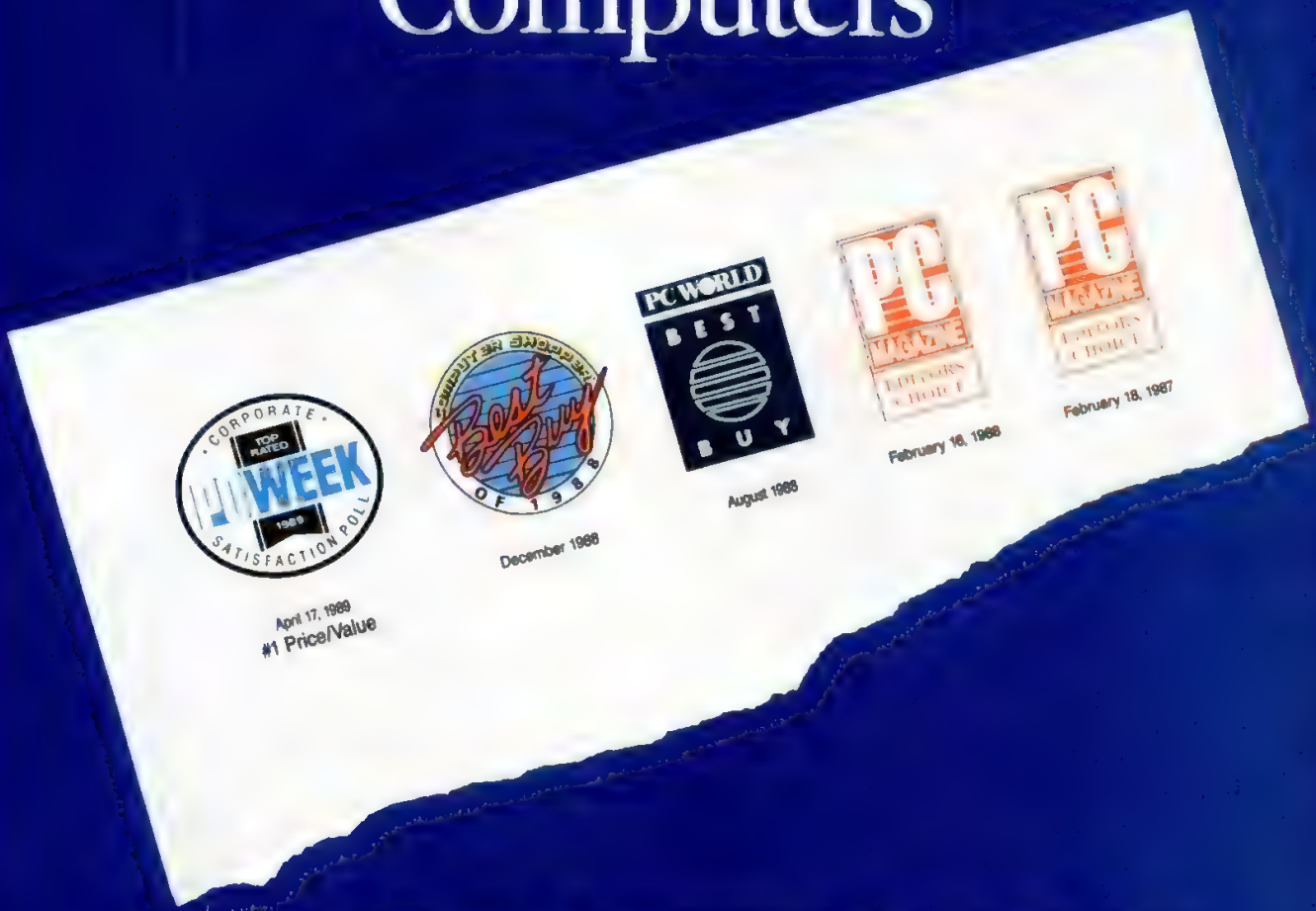

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—BusinessWeek, *November 13, 1989*

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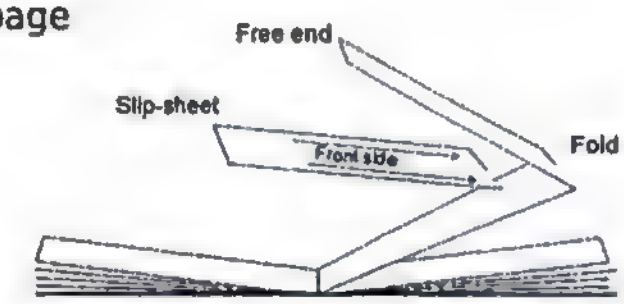
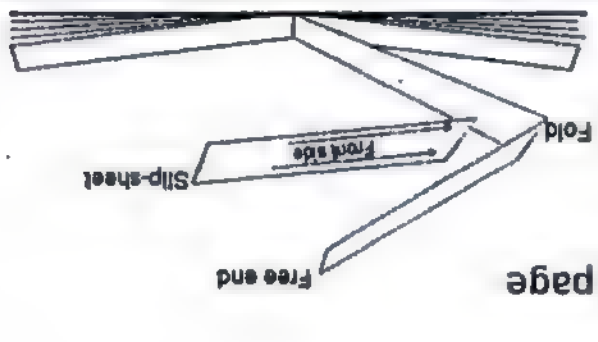
Foldout slip-sheet

1. Open the foldout page
2. Insert this sheet with
   1. Front side touching the free page
   2. Arrow pointing to the fold
3. Slice the folded edge
4. Close the page and slip-sheet



Inverted Foldout slip-sheet

1. Open the foldout page
2. Insert this sheet with
   1. Front side touching the free page
   2. Arrow pointing to the fold
3. Slice the folded edge
4. Close the page and slip-sheet



GbsSlipBack-001B

Back

1. Follow instructions on the other side

Inverted Back

1. Follow instructions on the other side

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— Practical Computing (UK), *April 1989*

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40MB (28ms)	$1699	$1664	$1894
80MB (19ms)	$1929	$1894	$2124
110MB (19ms)	$2129	$2094	$2324

80286 processor running at 20MHz • 512KB RAM expandable to 4MB • 0 wait state page-mode memory • Built-in dual hard drive interface, dual diskette drive controller, parallel port and two serial ports, and game port interface (requires cable, 48954) • Three full-size 16-bit and two half-size 8-bit expansion slots • 80287 math coprocessor socket • Choice of 5.25" 1.2MB or 3.5" 1.44MB diskette drive • 101-key enhanced keyboard

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— Computer Shopper, *June 1989*

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Color Monitor Optional.

	MVGA	CVGA
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80MB (19ms)	$2425	$2655
110MB (19ms)	$2625	$2855
150MB (18ms)	$3075	$3305

80386 processor running at 16MHz • 0 wait state page-mode memory • 1MB RAM expandable to 10MB • LIM 4.0 and disk caching support in ROM • Built-in parallel port and two serial ports • Five available expansion slots • Math coprocessor socket • Choice of 5.25" 1.2MB or 3.5" 1.44MB diskette drive • *40MB hard drive preloaded with FREE Microsoft Windows and DOS 4.01* • Dual diskette drive controller with dual hard drive interface • Monochrome VGA monitor and 16-bit video adapter • 101-key enhanced keyboard • FREE one-year onsite service

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other network resources. Another way to control network activity is to use *NET/30*'s "shortnames." This feature lets you assign names to disks and specify network users' access rights, such as read-, write-, or execute-only.

NET OPTIONS

Being a true peer-to-peer operating system, *NET/30* doesn't require a dedicated server; it allows for multiple servers on the network. You can connect up to two printers on each server, and a nifty management feature lets you examine, rearrange, and delete files in the print queue.

Hardware installation is quick and easy; just keep your manual handy for reference to switch settings and hardware configurations. Software installation takes a little more time: the commands you find in *NetWare*, such as Install, Load, and Map, are also used in *NET/30* installation. Install copies the system files to the hard disk, Load30 starts the software and defines servers and redirectors, and Map defines network disks and printers. The process is simple but not foolproof; you need to be attentive to detail lest you create conflicts among workstations and peripherals.

In the LAN Labs, we ran into one problem installing and running the *Invisible Software* network. The network interface boards have an on-board ROM that holds NetBIOS, but that ROM isn't fast enough to work effectively in computers with CPU speeds over 10 MHz. To make the system function, we had to load NetBIOS from a floppy disk.

One performance note: The package doesn't include disk caching software, but it should. Its relatively slow performance figures would have improved considerably with disk caching, though at the cost of some RAM in the server.

One plus for products from Invisible Software is that they are accompanied by a 30-day money-back guarantee, a lifetime warranty, and unlimited telephone and CompuServe support. That adds to *NET/30*'s attraction as a good, low-cost, reliable operating system. Just remember to read the manual carefully if you'll be installing the system in PCs with CPU speeds above 10 MHz.

It doesn't take a genius to operate *LANsmart*—you just need a basic understanding of DOS. Even installation is easy. Pop-up windows make it a breeze for everyone.

LANsmart Operating System

by Kimberly Maxwell

D-Link Systems' *LANsmart Operating System*, Version 2.0, is faithful to its name. All peer-to-peer network operating systems can share disks, files, and peripherals, but *LANsmart* is intelligently designed to run concurrently with systems such as Novell's *NetWare* and TCP/IP—something most small operating systems just can't do.

With D-Link's Ethernet cards and an added protocol interface, you can integrate your *LANsmart* network with bigger network operating systems and protocols like *3+Share*, *PC LAN*, SCO/Xenix, TCP/IP, and *NetWare*. (D-Link's 8- and 16-bit Ethernet cards—$325 and $450, respectively—emulate Novell's NE-1000 and NE-2000 Ethernet board and can run *NetWare* without additional driver software.) This means that a company running *LANsmart* can grow without necessarily limiting itself to D-Link's operating system, while one with an existing *NetWare* network, for example, can economically expand by adding low-cost *LANsmart* servers.

For $395, you can get *LANsmart* software to cover an unlimited number of users. In a small peer-to-peer network of five nodes, the cost per node is about $275 for the software and a 2.5-megabit-per-second (mbps) twisted-pair ARCnet card. The D-Link ARCNet Kit comes with a four-port hub, cards, cabling, and software; the network handles up to 255 nodes and can run to a distance of 20,000 feet. In addition to Ethernet and ARCnet boards, D-Link sells token-ring and 2.5-mbps twisted-pair adapters. The recently added token-ring cards are available in 8-bit, 16-bit, and Micro Channel versions.

LANsmart for Novell is a $595 product that allows Novell client stations to share hard disks, files, printers, and modems across the network. If you want to connect *LANsmart* to TCP/IP networks, you can do so using *LANmagic* ($1,395). With *LANmagic*, you simply touch a function key to switch among the various networks.

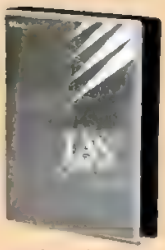
SMART FEATURES AND OPTIONS

It doesn't take a genius to operate *LANsmart*—you just need a basic understanding of DOS. A *LANsmart* network is compatible with DOS 3.1 and NetBIOS, and it does not require a dedicated file server, hard disk, or printer. To share resources using the *LANsmart* operating system, you grant network users authorization through passwords.

The latest version of *LANsmart* is simple to install. Pop-up windows prompt you along, and help menus make the process a breeze for the novice. The product maintains its reputation for low RAM requirements: it needs only 70K for the server station and a minuscule 2K (or 8K if you use the optional e-mail application) for each workstation on the network. *LANsmart* can also automatically make use of extended memory to provide more space for your applications.

LANsmart includes a disk-caching utility, a print spooler, remote boot capa-

FACT FILE



***LANsmart Operating System*, Version 2.0**
D-Link Systems Inc., 5 Musick, Irvine, CA 92718; (714) 455-1688.
List Price: $395 (unlimited users).
Requires: 70K RAM on the server, 2K RAM on each workstation, DOS 2.0 or later.
In Short: *LANsmart* provides capabilities unique to peer-to-peer network operating systems, such as its ability to run concurrently with Novell's *NetWare* and the TCP/IP protocol. Low RAM requirements and a low price make it a great product for the business in need of a peer-to-peer operating system that can work in conjunction with other LAN operating systems.

CIRCLE 398 ON READER SERVICE CARD

bility, and on-line chat and message communications. If you want additional software that runs under *LANsmart*, D-Link offers screen monitor, asynch communication, e-mail, and bridge packages.

D-Link's own bulletin board service comes in handy for information on upgrades; free technical support and classroom training are extra aids in helping you operate *LANsmart*. If you need a small operating system to run concurrently with *NetWare* and TCP/IP networks, *LANsmart* is the smart way to go.

LANtastic

by Kimberly Maxwell

Last year, Artisoft's *LANtastic* won our Editor's Choice award ("Low-Cost LANS," March 28, 1989) for its speed, services, and low price. Version 3.0, reviewed here, offers all of that plus a lot more, like a voice-chat feature within its e-mail system and the ability to talk with another network user over data wires using a handset or headset.

The package includes software and a $349 Ethernet card for each node; you can add a $149 voice adapter to enjoy the new voice feature. *LANtastic*'s voice e-mail is unique in a peer-to-peer operating system, and its features are comparable to those in the best voice-mail packages on the market. Among its options are create, erase, rewind, forward, pause, and a multibroadcast recipient list.

You insert the voice card into each PC equipped with *LANtastic*'s Ethernet card, a 2-megabit-per-second network adapter card, or any NetBIOS-compatible adapter. Since the operating system includes the voice-chat capability, you won't need any additional software. The *LANtastic* voice card translates a human voice into digital format and carries it over the LAN to a receiving machine. Once it arrives, the voice card translates the digital file back into sound so the person at the receiving machine can hear the message.

Via the handset or headset, you can carry on a conversation as if you were talking over a phone line. There is some delay when conversing, as in a long-distance telephone call. The voice card also allows you to send a recorded message and then play it back when the recipient logs onto the network.

On the visual side, *LANtastic*'s on-screen chat feature and improved e-mail allow you to exchange messages across the LAN. With e-mail, the message simply appears on-screen and stays there for a user-definable amount of time, disappearing automatically if you do not respond (it will be saved). You can designate the location for messages on-screen, and a pop-up e-mail notification warns the workstation of incoming messages.

SERVER MESSAGE BLOCK: DOS SHORTHAND FOR NETWORKS

by Frank J. Derfler, Jr.

DOS was not designed for network operation. Its architecture assumes fast communications between the operating system and the devices it controls. When DOS performs typical tasks, like creating directories or opening files, it sends commands in short sequences and often waits for confirmations.

In networks, the devices DOS controls reside at the other end of a long and (compared with internal PC speeds) relatively slow communications link between the client station and server. Multiple small messages and acknowledgements can quickly clog the communications channel.

Server Message Block (SMB), an internal communications protocol, was developed jointly by Microsoft, IBM, and Intel to make DOS more efficient over networks. The redirector in each networked client PC converts application programs' requests for action (such as opening, reading, writing, and closing files) into a special format for economical transmission across the network.

Software that follows the SMB protocol can optimize the data format to carry large or small blocks of information. The ability to retrieve and transfer 64K blocks of data leads to particularly efficient transfers across slow network routes and gateway communications links.

SMB can chain multiple requests for DOS activity into one network packet. For example, when you ask a database application on a client PC to retrieve a record from a LAN server, DOS goes through a series of actions involved with opening the file under various sharing conditions and reading a specific range of bytes. SMB gathers these requests together, encloses them in a specially constructed data block, and ships them economically across the LAN.

At the other end, the server recognizes the SMB requests and handles them efficiently with a few tricks of its own. For example, if an application requests shared use of a file but no other application is using it at the time, the server software will give the application exclusive use of the file so that the server doesn't have to track file pointers. Of course, the software will share the file if another application asks for it later.

For many people, the interesting point about SMB is that the protocol is in the public domain. This means that companies other than Microsoft and its licensees can develop workstation and file server software of their own that will interoperate with software from all the companies selling Microsoft's *MS-Net* and *LAN Manager* (AT&T, Compaq, IBM, 3Com, and many others). Thus, CBIS's *Network-OS*, DCA's *10Net Plus*, D-Link's *LANsmart*, and Moses Computers' *PromiseLAN* all follow the SMB protocol. If the software and hardware at the lower levels—like NetBIOS and Ethernet—are compatible, a workstation loaded with a redirector from one of these companies can access files on servers running software from the other companies.

In reality, though, the interface between these different products can be tricky to set up. Some companies created "extensions" to SMB for their own purposes, so all the functions of these networks won't necessarily work across all servers. However, the companies usually know what you need to make the SMB interface work.

The Server Message Block is not an international or IEEE standard, but it has the support of many important companies and organizations. Therefore, if you select networking software that uses SMB, you'll be keeping your options open. ■

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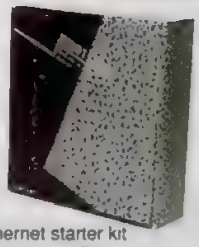
The *LANtastic* voice-message recording menu shows off a feature unique to this package. The pointer moves along the scale as you record or play back a voice-mail message. You can back up and restart playing or recording at any spot.

FACT FILE

EDITORS' CHOICE



***LANtastic*, Version 3.0**
Artisoft Inc., 575 East River Rd., Tucson, AZ 85704; (602) 293-6363.
List Price: $349 per node (includes Ethernet card); voice adapter card, $149. Ethernet starter kit (software for 2 to 120 users, two Ethernet cards, 25-foot coaxial cable, terminators), $725.
Requires: 256K RAM, NetBIOS-compatible adapters, DOS 3.1 or later. (DOS 3.2 not recommended.)
In Short: A low RAM requirement, good pricing, improved security features, and disk caching are but a few of *LANtastic*'s many attributes. The system's unique new voice-chat capabilities are an enjoyable surprise.

CIRCLE 399 ON READER SERVICE CARD

FANTASTIC FEATURES

The system's server station requires 40K RAM, and the workstations take up a small 13K of memory. You can load the operating system into expanded memory or place the disk-caching program into extended or expanded memory. This frees up enough room for large applications requiring more RAM.

The *Quick-Install* program automatically assigns network resources, account files, and privileges. It modifies the CONFIG.SYS file with the appropriate files, buffers, FCBs, and Lastdrive designation, and creates a batch file that activates the network in one command. If you have any difficulties using the *Quick-Install* program, an on-line help menu, which automatically scrolls to the section you are working in, stands ready to aid you. Additionally, technical assistance is available Monday through Friday, as is a BBS monitored by a full-time system operator.

Artisoft has improved *LANtastic*'s printing features in Version 3.0. One important addition is the print server's ability to feed jobs to multiple printers simultaneously. This lets you print specific jobs with a high-priced laser while the spooler searches through the queue for any files that can be output by one of the network's lower-end devices.

You can also increase the size of the network printer buffers and specify the location of spool files on the disk. Both of these improvements help make the printing process more practical. A new feature for global clearing of the print queue allows you to dump the entire contents of the queue at once, rather than one file at a time. This comes in handy when someone doesn't understand the delays in network printing and repeatedly submits the same job for printing.

LANtastic's disk cache allows applications to have fast, repetitive access to data files. On our benchmark tests, *LANtastic* outperformed all its competitors with phenomenal speed.

Diskless workstations are common in local area networks, and *LANtastic* supports them. With Artisoft's on-board ROM chips, the *LANtastic* software creates a boot image so that a diskless workstation can boot up automatically.

LANtastic's security allows you to assign each user access to the system during certain hours. This is particularly useful in colleges where a limited number of PCs must be shared by many students. Near the end of the specified time period, a warning message displays the time remaining before the user will be logged off the network; the message remains on-screen until the operating system logs off. You can also specify a date for closing an account, which is quite convenient when you are managing temporary personnel.

Amid all of this praise, it's a hard struggle to find some cautionary note that ought to be sounded regarding *LANtastic*. The only potential problem relates to the fact that *LANtastic* is optimized for performance and simplicity. It doesn't carry a lot of compatability baggage, and this would be a stumbling block for anyone wanting a growth path to larger Microsoft and Novell networks. Nonetheless, you can expand a *LANtastic* network with many servers to satisfy the needs of 100 or more client stations.

LANtastic's voice-chat feature, improved security, disk cache, and high performance—not to mention the same low price that graced last year's Editor's Choice version—make Artisoft's package even more appealing if you are looking for a sound peer-to-peer network operating system.

Network-OS

by Bruce Mayfield

CBIS, a ten-year-old company, is waging war in the name of economy and productivity against the acknowledged LAN operating system leader, Novell. *Network-OS*, Version 6.30B—available for $160 per node or for a flat fee of $1,480 (up to 80 nodes) or $2,550 (255 nodes)—brings you the performance and features you would normally expect in higher-priced LANs.

Network-OS is hardware independent: CBIS doesn't sell network interface cards, but the product supports over 50 different models, including Micro Channel boards and adapters for portable computers. The software also uses the Server Message Block (SMB) protocol (see the sidebar "Server Message Block: DOS Shorthand for Networks"), so you can link *Network-OS* servers and workstations to other SMB network nodes. Full NetBIOS services are also supported.

A true peer-to-peer LAN, *Network-*

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OS enables any PC to contribute its devices to the network. You can configure a machine as a combination server/workstation or completely dedicate it to network tasks by adjusting CPU time-slicing options. The software's design allows for multiple servers of various types; and after a server crash, *Network-OS* will automatically reconnect to the other workstations when you restart. *Network-OS* also supports remote booting, making it possible to include diskless workstations in your scheme.

Network-OS's menu-driven installation is easy, and it is complemented by on-screen help. The help screens provide recommended default settings, which come in handy if problems arise when fine-tuning the network while on-line.

Unfortunately, the CBIS manual doesn't go beyond the installation procedures to translate the system's practical features into how-to benefits for the average user. Furthermore, the manual doesn't explain path statements, file locations, shared-use applications, and other necessary information. CBIS does offer such options as personal training, a video, and a technical support hotline.

A NETWORK WITH PERSONALITY

One valuable feature of *Network-OS* is its "portable personality." *Network-OS*'s log-on process allows any server or workstation to recognize you, your data, and your software as a uniquely configured personality, and you can access your personal resources, such as files stored on local drives, from any PC.

You can easily switch printer assignments among LPT1, LPT2, LPT3, COM1, and COM2 using a supplied TSR utility. If the normal printer is off-line, a pop-up screen gives you access to another device on the network. The queue control allows workstation spool-file viewing while you are waiting for printouts. *Network-OS*'s direct print feature allows priority users to bypass the print queue temporarily and capture a printer. The program also allows you to set up sheets with identifying headers between print jobs to minimize confusion in finding users' output.

Most software written for Novell or DOS file/record locking will operate in *Network-OS* without disk reformatting. Exceptions are products that use older versions of Novell's *Semaphore* and software that specifically checks for the name "Novell" or a Novell ID.

A standard feature of *Network-OS* is file caching in extended memory. (If you have a hard disk larger than 70MB, you should check with CBIS about caching limitations.) *Network-OS* doesn't let other programs use extended memory on the PC with a file cache.

Unfortunately, *Network-OS* occupies a lot of base memory that is often needed by TSR and memory- intensive graphics programs. The bare-bones server configuration uses 120K RAM; workstations need 60K. Should an application need more space on a server than is available, *Network-OS* is designed to permit loading the operating system into DOS memory above 640K with "memory expanders" (not to be confused with expanded or extended memory) from third-party vendors.

We were able to run some memory-hungry sorting utilities only after rebooting the server without its memory-resident spooler and printer-control software. (CBIS does not allow unloading memory-resident software; you must reboot.)

Data security within *Network-OS* is addressed through password protection and encryption. *Network-OS* sets share/read/write attributes at the file level when desired. You can use password protection on your directories to protect the files within them, but CBIS does not address individual file password restrictions. Generally that's not a problem because you will usually want to protect a group of related files anyway.

Network-OS includes a very basic e-mail group-broadcast feature, but CBIS's *Right Hand Man*—a workgroup productivity package with e-mail, scheduling, and many other features—may be worth getting if e-mail is important to you. The company's *CD Connection* enables *Network-OS* users to share up to 23 High Sierra or ISO 9660 formatted CD-ROMs.

CBIS supplies *Network-OS* to a few other companies selling repackaged value-added versions. Performance Technology offers *Network-OS* as *POWERlan* (Performance Technology, 800 Lincoln Ctr., 7800 IH 10 West, San Antonio, TX 78230; (800) 825-LANS, (512) 349-2000). Datapoint calls its version *DataLAN 4* (Datapoint Corp., Direct Marketing Services, Mail Stop 30, 9725 Datapoint Dr., San Antonio, TX 7829-8500; (800) 334-9968).

While the penalties imposed by its file caching in extended memory may annoy some people, in most other respects *Network-OS* stacks up just fine. Its print options, its easy installation, and especially its portable personality will make it a fine choice for many users.

FACT FILE

***Network-OS*, Version 6.30B**
CBIS Inc., 5875 Peachtree Industrial Blvd., Building 100, Suite 170, Atlanta, GA 30092; (404) 446-3337.
List Price: 2 to 7 nodes, $160 per node; up to 80 nodes, $1,480; up to 255 nodes, $2,550.
Requires: 640K RAM, DOS 3.1 or later.
In Short: *Network-OS* is a competitively priced DOS-based network operating system definitely worth looking into. Highly compatible with a large number of topologies, it features a "portable personality" configuration, good printer-sharing capabilities, e-mail, disk caching, easy installation, and optional CD-ROM support.

CIRCLE **400** ON READER SERVICE CARD

PORT Lite

by Kimberly Maxwell

You walk in and out of different rooms everyday. Now Waterloo Microsystems invokes this metaphor to give its *PORT Lite* LAN a friendly and intuitive interface: the software presents each user with an individual office environment where icons labeled as rooms represent available resources, subdirectories, programs, and files. The approach not only makes *PORT Lite* easy for the novice to understand but also fills a gap in the LAN operating system market.

Geared toward smaller businesses and offices lacking a resident technical expert, *PORT Lite* includes software for five users, cabling, and two ARCnet cards for $995. If you use other vendors' Token-Ring or Ethernet interface boards, you'll be happy to know that *PORT Lite* is compatible with the NetBIOS interface on most of those products.

The software supports up to five workstations, but the $495 *PORT Lite* Expander lets you add workstations to your LAN in increments of five. When you reach 25 workstations, an upgrade to the company's bigger and more powerful operating system, *Waterloo PORT*, is available. *Waterloo PORT* can handle over 250 workstations, and it uses the same icons as *PORT Lite*.

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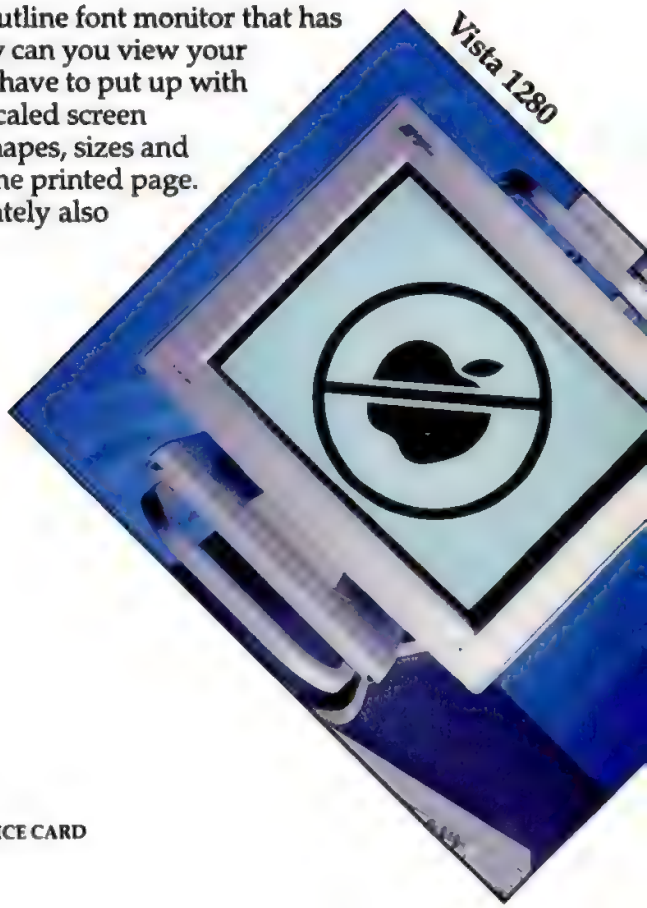

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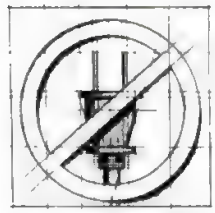

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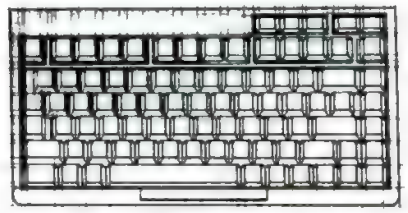
Finally, we gave it a 40MB hard disk, a 1.44MB 3.5" floppy disk drive and 1 megabyte of RAM, which you can expand up to 13MB. All in an easy-to-carry, 14.9-pound package that goes wherever your work is.



The ergonomically-designed 86-key keyboard features eight dedicated cursor control keys, 12 function keys and a numeric keypad.

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CIRCLE 379 ON READER SERVICE CARD

All actions in the *PORT Lite* environment take place through an icon-based menu structure. This user console screen lets you open doors and enter "rooms" containing specific types of application software.

LIGHTING IT UP

By making *PORT Lite* easy to use, Waterloo Microsystems attempts to fill a niche below the level occupied by Novell, 3Com, and Banyan. The program comes on ten disks, and you'll need patience during installation. But with its complete documentation and help screens, anyone who understands the basics of DOS can install *PORT Lite* in about an hour.

Yet *PORTLite* is actually a unique non-DOS operating system. At the beginning of the install process, you're asked whether you would like to assign the server's entire hard disk to *PORT Lite*. If you do, all files in its partitions are destroyed when the disk formats to *PORT Lite*. But you don't have to wipe the slate clean: if you keep DOS, the documentation explains how to make a partition for *PORT Lite*.

When setting up your network, you determine whether or not the server will be dedicated. We tested *PORT Lite* with twisted-pair ARCnet cards in five Dell PCs, one of which acted as the nondedicated server. (Waterloo Microsystems advises purchasing an optional ARCnet hub when using more than two workstations on an ARCnet network without twisted-pair cabling.)

Every machine acting as a server or workstation with shared resources requires a special 2MB hard disk partition and at least 384K of extended memory. Waterloo Microsystems suggests having at least 2MB of RAM on *PORT Lite* servers. The software in workstations that will not share resources consumes about 64K RAM.

ROOMY SOFTWARE

PORT Lite allows each user to arrange the room icons in a unique display. The various rooms can be given descriptive

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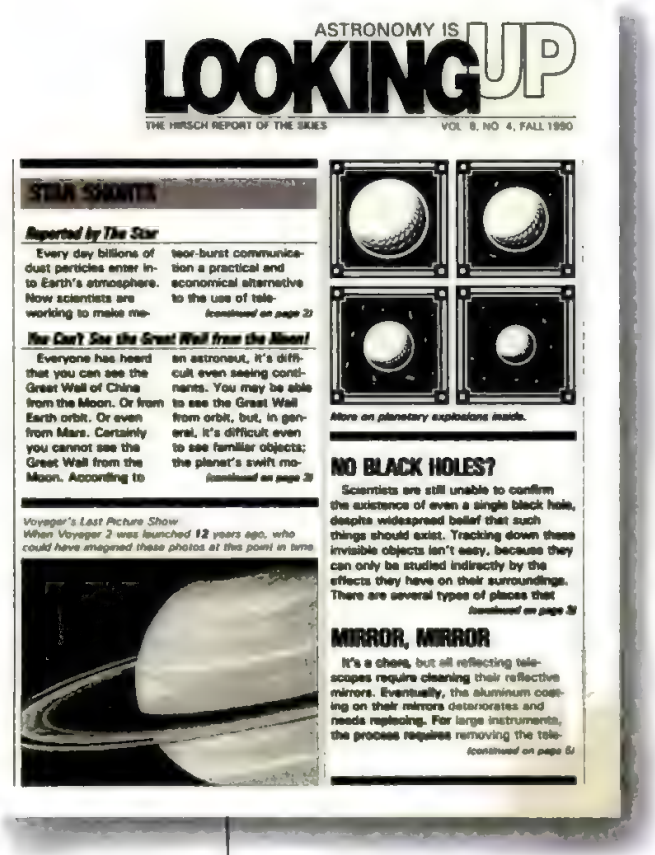


ASTRONOMY IS LOOKING UP

THE HIRSCH REPORT OF THE SKIES VOL. 8, NO. 4, FALL 1990

STAR SHORTS

Reported by The Star

Every day billions of dust particles enter into Earth's atmosphere. Now scientists are working to make meteor-burst communication a practical and economical alternative to the use of tele-

(continued on page 2)

You Can't See the Great Wall from the Moon!

Everyone has heard that you can see the Great Wall of China from the Moon. Or from Earth orbit. Or even from Mars. Certainly you cannot see the Great Wall from the Moon. According to an astronaut, it's difficult even seeing continents. You may be able to see the Great Wall from orbit, but, in general, it's difficult even to see familiar objects; the planet's swift mo-

(continued on page 3)

Voyager's Last Picture Show
When Voyager 2 was launched 12 years ago, who could have imagined these photos at this point in time

More on planetary explosions inside.

NO BLACK HOLES?

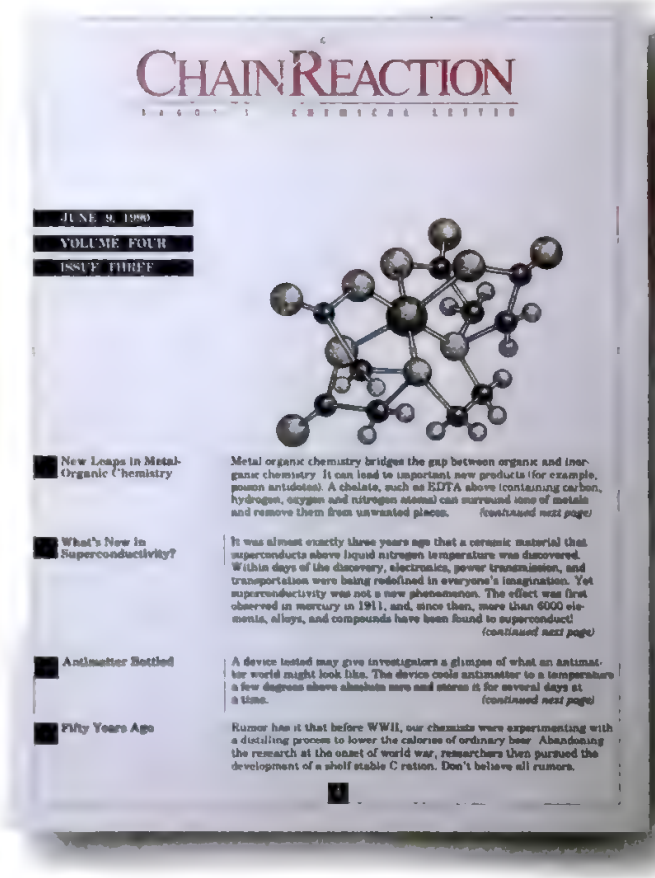
Scientists are still unable to confirm the existence of even a single black hole, despite widespread belief that such things should exist. Tracking down these invisible objects isn't easy, because they can only be studied indirectly by the effects they have on their surroundings. There are several types of places that

(continued on page 3)

MIRROR, MIRROR

It's a chore, but all reflecting telescopes require cleaning their reflective mirrors. Eventually, the aluminum coating on their mirrors deteriorates and needs replacing. For large instruments, the process requires removing the tele-

(continued on page 6)



CHAIN REACTION

JUNE 9, 1990
VOLUME FOUR
ISSUE THREE

New Leaps in Metal-Organic Chemistry

Metal organic chemistry bridges the gap between organic and inorganic chemistry. It can lead to important new products (for example, poison antidotes). A chelate, such as EDTA above (containing carbon, hydrogen, oxygen and nitrogen atoms) can surround ions of metals and remove them from unwanted places. *(continued next page)*

What's New in Superconductivity?

It was almost exactly three years ago that a ceramic material that superconducts above liquid nitrogen temperature was discovered. Within days of the discovery, electronics, power transmission, and transportation were being redefined in everyone's imagination. Yet superconductivity was not a new phenomenon. The effect was first observed in mercury in 1911, and, since then, more than 6000 elements, alloys, and compounds have been found to superconduct! *(continued next page)*

Antimatter Bottled

A device tested may give investigators a glimpse of what an antimatter world might look like. The device cools antimatter to a temperature a few degrees above absolute zero and stores it for several days at a time. *(continued next page)*

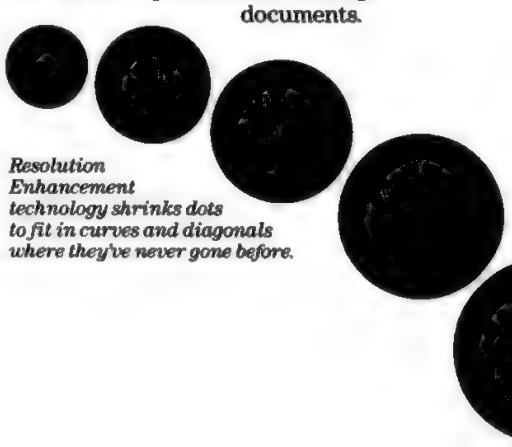
Fifty Years Ago

Rumor has it that before WWII, our chemists were experimenting with a distilling process to lower the calories of ordinary beer. Abandoning the research at the onset of world war, researchers then pursued the development of a shelf stable C ration. Don't believe all rumors.

Introducing the new HP LaserJet III printer with Resolution Enhancement technology.

The rules have changed. Now the name of the game is Resolution Enhancement technology. You'll call it the best thing to happen to laser printing since the very first HP LaserJet printer. It gives you clearer resolution. Curves that really curve. And edges that are never jagged.

Instead of a "one-size-fits-all" dot, HP's built-in intelligence varies dot sizes. So they can fill areas where they could never go before. For clearer, more professional-looking documents.



Resolution Enhancement technology shrinks dots to fit in curves and diagonals where they've never gone before.

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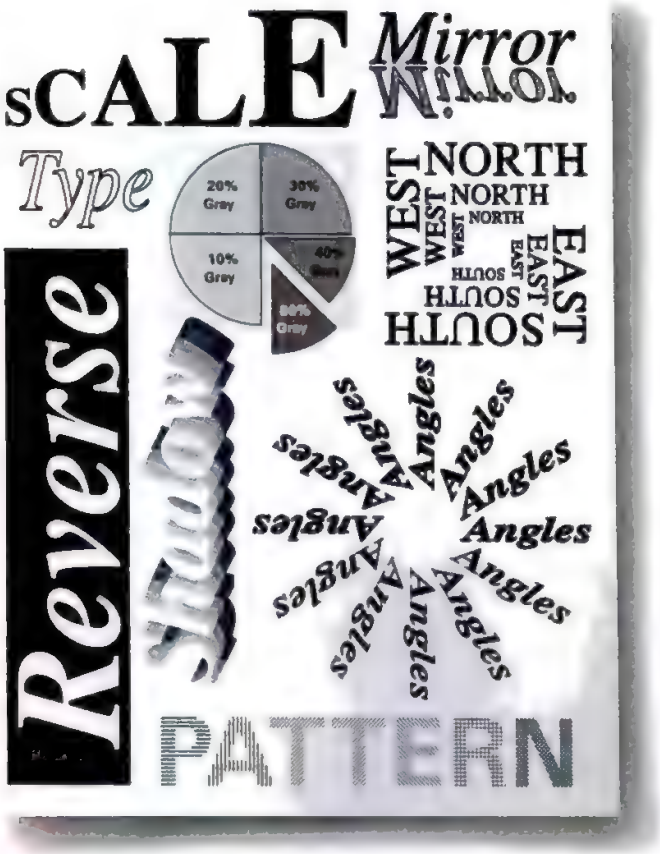
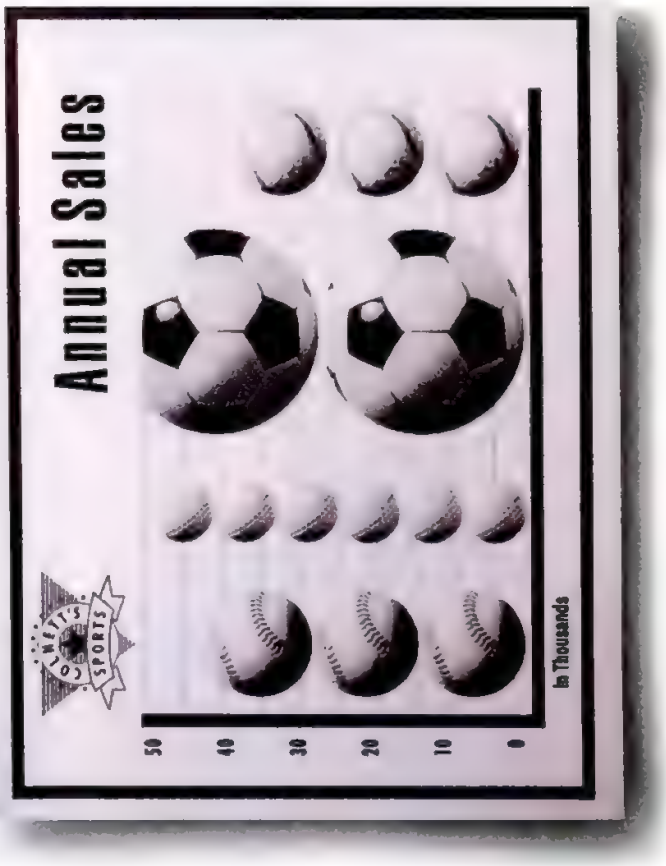
whole new ball game.





But there's more than better print quality. 14 bit-mapped fonts and 8 internal scalable typefaces provide thousands of options. And enhancements to our PCL5 printer language, including our HP-GL/2 graphics language, let you print portrait and landscape on the same page. Reverse and angled type. Spirals. Even shaded text. You can also plug in Adobe PostScript® software.

For all its new features, the $2,395* list price of the HP LaserJet III is a good deal less than the HP LaserJet

Series II printer it replaces. With the same hardware compatibility, wide range of applications, 8 ppm print speed, and software compatibility, including WordPerfect 5.1 and WordStar® 6.0. And the same reliability as the rest of the HP printer family.

So call **1-800-752-0900, Ext. 1007.** Ask for our booklet on Resolution Enhancement technology and where to find your nearest authorized HP dealer. We'll put you in a whole new league.

There is a better way.

HEWLETT PACKARD

*Suggested U.S. list price. WordStar is a U.S. registered trademark of WordStar International Incorporated. Adobe and PostScript are registered trademarks of Adobe Systems, Inc.

CIRCLE 491 ON READER SERVICE CARD

FACT FILE

***PORT Lite*, Version 2.5**
Waterloo Microsystems, 295 Phillip St., Waterloo, Ontario, Canada N2L 3W8; (519) 884-3141.
List Price: Starter LAN (software for 5 users and two ARCnet cards), $995; software only (5 users), $695.
Requires: 640K RAM, DOS 2.1 or later. Extended memory required for server or workstations sharing peripherals and a hard disk.
In Short: Graphics-interface icons make the *PORT Lite* operating system easy for the novice to install and manipulate. It's an attractive product for the small business or office that needs a full-blown operating system but does not have an in-house technical expert.

CIRCLE 401 ON READER SERVICE CARD

names that tell more than DOS's abbreviated filenames, making it much easier for you to distinguish and organize applications in a satisfactory arrangement.

Unique to the server station is the "supPORT room." Here, *PORT Lite* lists information to help diagnose problems with the system. If you have to call for assistance, the information in this room will help the company's technical support staff find the difficulty.

PORT Lite's mail feature provides message filing and organization, registered mail, and an on-line directory. If you don't want to use the software's mail system, the network manager can install any one of several vendors' mail applications on the network.

The company's BBS can be accessed for more information about its product lines and for technical updates. For additional training, classes are offered in the Toronto area, and a representative can be sent to a customer site on request.

Among the virtues of *PORT Lite* are its simple installation and ease of use—particularly welcome to novices. But while technical hassles are few, the need to dedicate a portion of the server's hard disk to a non-DOS operating system could scare away some potential users.

10Net Plus

by Kimberly Maxwell

The ability to free up memory for RAM-hungry applications, a caching program that speeds operations, and workgroup-scheduling facilities characterize *10Net Plus*, Version 4.1, a peer-to-peer network operating system from Digital Communications Associates (DCA). The system runs over a wide variety of DCA hardware, including fiber-optic cables that meet the federal government's TEMPEST specifications.

DCA prices its software at a reasonable $195 per node, although if you want an Ethernet card bundled with the package you'll have to shell out $695. The software uses the SMB protocol, so you can intermix *10Net* servers with other SMB-compatible servers on the same network.

The program requires 90K RAM for the server station and 55K for each workstation on the network. If your machine loses a large amount of RAM to memory-hungry applications, you can load a portion of the operating system software into extended, expanded, or high memory.

The disk cache system that comes with *10Net* helps improve the performance of the operating system. The 10CACHE profile lets you specify what kind of memory you want to use for the cache. A status program gives information about the performance of the cache system functions, which is useful for the network administrator who wants to fine-tune the system's operation.

The network security system protects files from damage caused by multiple-user access; it also tracks network log activities. A status feature allows monitoring station resources.

TRACKING AND CHATTING

The NetBIOS-compatible *10Net* comes supplied with two calendar functions. 10CALMAS acts as a workgroup scheduler for the entire network; 10CAL is a simplified schedule for individual workstations. Both are well implemented and helpful in keeping schedules.

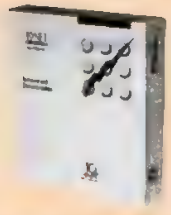
10Net's electronic mail facility is strong, but one feature that really stands out is CB, the on-line conference facility. You select one channel among the 40 available to "converse" with others on the same line. You have 8 to 14 lines available for your message; the feature is easy to use, and help menus appear at the touch of a button. If you want, you can log your CB activity.

The chat feature is another fun and convenient way to communicate—particularly handy for sending short messages to a specific user. A single keystroke brings up the chat window, which can actually be used to control more than chatting: you can use it to manipulate print spooling, monitor network transmission, submit DOS commands from one machine to another, and work in network debug routines. Choosing the print-spool option, for instance, lets you initiate, terminate, abort, and print your spooled files. The Communication Tally feature provides information about your network communications; it shows network errors and messages sent and received.

Despite *10Net*'s wealth of features, the program is easy to install. The default configurations work fine, but it's also easy to customize individual user profiles. In case you have any difficulty with *10Net*'s installation, DCA has a toll-free number; you can also sign up for classroom training. DCA's helpful BBS is available to provide further information about the company and its products.

10Net's card, cabling, and software packaging alternatives make it more flexible than most peer-to-peer networks. For example, you can purchase a $1,295-per-node 10-megabit-per-second fiber-optic LAN package consisting of a *10Net* fiber board, software, and documentation. In place of the Ethernet and fiber-optic hardware platforms, you can opt for twisted-pair wiring. The $395 *10Net TCP* is an implementation of the standard TCP/IP protocol family for PCs running DOS, and it lets *10Net* talk to many computers running diverse operating systems.

FACT FILE



***10Net Plus*, Version 4.1**
Digital Communications Associates Inc., 7887 Washington Village Dr., Dayton, OH 45459; (513) 433-2238.
List Price: $195 per node; with Eternet card, $695.
Requires: 90K RAM, IBM-compatible or RFC-compliant NetBIOS and hardware interface, DOS 3.0 or later.
In Short: *10Net Plus* has strong network communications, scheduling, and other utilities that set it apart from the competition. RAM hunger isn't a problem because you can load the software into extended or expanded memory.

CIRCLE 402 ON READER SERVICE CARD

ZEOS® 386™SX.

"With so much going for it, how could you go wrong?"

PC Magazine

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386SX

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PC Magazine, On why the ZEOS® 386SX Wins Editor's Choice.

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For instance. Unlike most of the others, ZEOS maintains its own chip level Research and Development staff *plus* our own board level manufacturing facilities. All right here in St. Paul. When it comes with the ZEOS® name it comes with World Class Quality. It's the best you can buy.

You are saving too because you are buying direct from ZEOS. And you can buy with confidence because ZEOS is a strong and rapidly growing public company (NASDAQ Symbol: ZEOS). Our professional Systems Consultants and expert Technical Support staff serve tens of thousands of customers World Wide, twenty four hours a day. And these are happy customers. How do we know?

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☐ UPS ground add $35.00

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Subtotal: _____

Shipping: _____

ORDER TOTAL: _____

FOR COD ORDERS ONLY

Less COD deposit of $200 per system $ —

COD balance due on delivery $ _____

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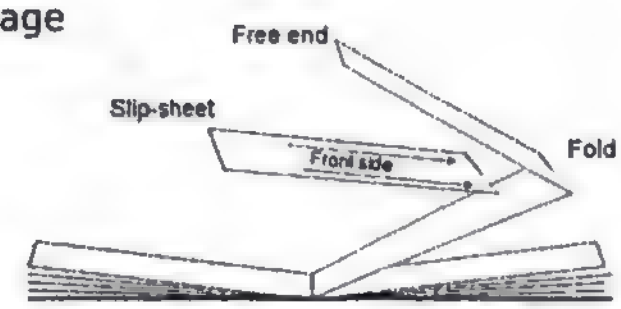
GbsSlipSheet-001

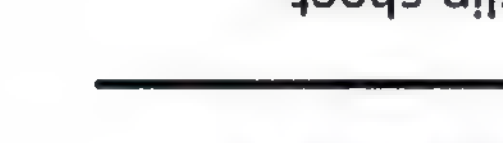
Foldout slip-sheet

1. Open the foldout page
2. Insert this sheet with
   1. Front side touching the free page
   2. Arrow pointing to the fold
3. Slice the folded edge
4. Close the page and slip-sheet



Inverted Foldout slip-sheet

1. Open the foldout page
2. Insert this sheet with
   1. Front side touching the free page
   2. Arrow pointing to the fold
3. Slice the folded edge
4. Close the page and slip-sheet



GbsSlipBack-0018

Back

1. Follow instructions on the other side

Inverted Back

1. Follow instructions on the other side

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10 Good Reasons To Buy From ZEOS®

Reason #1

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As *PC Magazine* said "Price is always a consideration. So are bench mark test results. But both factors can be deceiving, which is why we consider them in the context of other aspects that will make the difference months and years down the road."

These are the attributes which *PC Magazine* used in awarding ZEOS the coveted Editor's Choice, not once but three times. And "Overall Excellence" are the very words *PC Magazine* used in describing ZEOS systems comparing them to all others.

Reason #2

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In one recent '386 review, *PC Magazine* awarded ZEOS Editors Choice. "The ZEOS '386 blows away every other computer... a smart choice" is what they said. And in another recent review, *Government Computer News* said the ZEOS 33MHz '386 is "arguably the fastest MS-DOS and OS/2 micro in the world."

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Reason #3

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PC Resource Magazine put it this way, "ZEOS ... provides quality comparable with IBM or Compaq and does so for about 70% of the price." ZEOS uses only the very best components. And every system is fully tested and burned-in right in our own labs.

Reason #4

Value.

InfoWorld says, "We find the ZEOS '386 an excellent value. Speed: Excellent. Compatibility: Excellent. Value: Excellent." *Personal Computing* said, "ZEOS...is the best value we've come across...its performance is right up there with the slickest, most expensive PCs you can buy."

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Reason #7

Experience.

Almost unique in the mail order computer industry, ZEOS maintains its own chip level Research and Development staff. In addition to Systems Manufacturing, we also operate our own Board Level Manufacturing facility.

ZEOS has been involved in Research and Development since our incorporation back in 1981. Our strong and experienced Research, Manufacturing and Technical Staff translates into superior factory direct computer systems for you.

Reason #8

A Sterling Reputation.

In magazine after magazine and review after review ZEOS systems are cited for Overall Excellence, for Excellent Value, as the Right Choice and so on. All of this is flattering but the most important thing is this: What do our customers think? Frankly, they love us. The systems and the support. That means more to us than anything.

Reason #9

Easy to Buy.

ZEOS systems are easy to buy. You can pick up the phone any time of the day or night and order your new ZEOS computer. And we accept MasterCard, Visa, and Corporate Purchase Orders from Fortune 1000 Companies, Colleges, Universities and Governments. Complete Leasing Programs are available as well.

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a. Your Personal Information

Requested Line of Credit $ _____

Your Name _____ First Initial Last **Date of Birth** _____ Mo. Day Yr.

Present Address _____ Street Apt. # City State Zip

Social Security Number _____ ( ) Home Phone

Date of Residence _____ Month Year **Monthly Payment** $ _____ ☐ Buy ☐ Rent ☐ Other

Previous Address _____

_____ **Dates of Residence** _____ From To

Your Employer _____
(If self-employed, see rear panel.)

Date of Employment _____ Mo. Yr. **Position** _____

Monthly Income _____ Gross $ Net $

Employer's Address _____ Street

_____ City State Zip ( ) Business Phone

Previous Employer _____ **Address** _____

_____ **Dates of Employment** _____ From To

Other Income _____ I have received since (Date) _____
Income from alimony, child support or separate maintenance payments need not be disclosed if you do not wish to have it considered as a basis for repaying this obligation.

Monthly Income _____ Gross $ Net $

Name and Address of Nearest Relative Not Living With You _____

_____ Relationship _____

b. Credit Information

Include joint information, if joint account requested.

Bank Account _____ Bank Name ☐ Checking ☐ Savings

Address _____

Bank Account _____ Bank Name ☐ Checking ☐ Savings

Address _____

Bank Loan Reference _____ Bank Name Address

_____ Payment _____ Balance _____

Bank Card Reference _____ Bank Name Address

_____ ☐ VISA ☐ Mastercard Payment _____ Balance _____

(please check appropriate box):

☐ **Joint Credit** with another person. Complete all information.
☐ **Individual Credit** but rely on income or assets of another person as a basis for repaying the credit requested. Complete all information
☐ **Individual Credit** Complete sections "a" and "b" only.

Please complete all appropriate sections, *providing at least two years' residence and employment history.* This will enable your information to be processed as quickly as possible. If you are self-employed, please be sure to complete section "d" below.

Other Credit Card Reference _____ Bank Name Address

_____ Payment _____ Balance _____

Other Credit References _____ Payment _____ Balance _____

Account No. _____ Expires _____

Driver's License No. _____ State _____ Expires _____

c. Joint Personal Information

Joint Name _____ First Initial Last

Date of Birth _____ Mo. Day Yr. **Social Security Number** _____

Address _____ Street Apt. #

_____ City State Zip

Date of Residence _____ Mo. Yr. **Home Phone** ( )

Employer _____

Date of Employment _____ Mo. Yr. **Position** _____

Monthly Income _____ Gross $ Net $

Employer's Address _____ Street

_____ City State Zip ( ) Business Phone

d. Self-Employed Information

Complete this section only if you are self employed.

Business Name _____

Business Address _____

☐ Proprietorship ☐ Corporation ☐ Partnership **Business Phone** ( )

Description of Business _____

Your Position _____ **In Business Since** _____

Your annual income from business _____ **Business' annual income** _____ (gross) (net)

You must provide at least one of the following:

1. Business Bank _____

( ) Telephone _____ Personal Banker's Name _____

2. Accountant's Name _____

( ) Telephone _____

3. Financial statement on business attached.

(EXC. AK, & HI)

CIRCLE 115 ON READER SERVICE CARD

This *10Net Plus* menu shows three PCs making their C: drives available to client stations. The station shown as SERVER2 is the local PC. SERVER1 is making a subdirectory—but not its entire disk—available to the network.

If you need a flexible and multifeatured network operating system, *10Net* is a good solution. You'll like its compatibility with other network operating systems, its well-implemented features, and the simplicity of its internal communications and scheduling utilities.

TOPS Network Bundle for DOS

by Bruce Mayfield

TOPS Network Bundle for DOS (a superset of the *TOPS/DOS* operating system) conquers the gap between Apple Macintosh and IBM-compatible PCs for many LAN users. Its arsenal of utilities will appeal to users who want a permanent Mac-to-PC or PC-to-Mac data-conversion system.

The *TOPS/DOS* software alone sells for $249 per node, or you can get the *TOPS Network Bundle* "10 pack" for $995, plus $239 for each TOPS FlashTalk adapter. The TOPS software includes drivers for the Western Digital EtherCard Plus, 3Com EtherLink II, and EtherLink/MC cards.

The system's menu-driven installation is simple, but that very simplicity limits you to a basic no-frills LAN technology. In fact, thanks to the many hidden files the program creates, even the installation won't be easy if you get the serialized disks of one station mixed up with those from another, as we did. It's to your advantage to work on one machine at a time, keeping all other sets of disks isolated until you finish the process.

The program doesn't provide for user log-on security nor for personalities that are portable between workstations, as *Network-OS* does. What's more, you cannot exercise time-slice control options for fine-tuning file server performance—something many LAN users depend on. *TOPS/DOS* does let you decide whether to use a PC as a dedicated or a nondedicated server.

TOPS/DOS is best at letting a Macintosh use a PC's hard disk for auxiliary online storage within a LAN. Even though the Mac data stored on the PC is not always compatible with PC applications, in combination with the conversion utilities that are standard on a Mac, *TOPS/DOS* creates a useful PC-to-Mac data-conversion environment. (*TOPS/DOS* will also bridge to a Unix environment, but only on Sun Microsystems workstations.)

Before purchasing *TOPS/DOS*, you should check with the company to make sure the software you intend to use in a mixed-network environment will perform according to your expectations. After receiving help from TOPS in making prudent software selections, you can expect transparent bridging of data. TOPS also supplies helpful configuration notes on some software packages that may need tweaking for a Mac/DOS environment.

POSSIBILITIES AND LIMITATIONS

Even with the most compatible software bridge, do not expect your Mac to print to your PC's printers, or vice versa, unless the devices are AppleTalk-compatible. Printer support across the PC/Mac bridge is a one-way street.

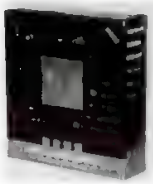
We tested the system with 3Com EtherLink II adapter cards. You can use Apple's LocalTalk twisted-pair system with *TOPS/DOS* FlashTalk cards and Farallon connectors. Even with Ethernet, do not expect blinding speed compared with other networking schemes; *TOPS/DOS* simply does not give high throughput, even over relatively fast adapters.

TOPS/DOS includes DOS-extender software from Rational Systems to save memory. It can also take advantage of extended memory, thus requiring as little as 80K of base memory. If don't have extended memory, the Unload command may be your best option for freeing some of the 190K of base memory used by PCs acting as *TOPS/DOS* servers. You can also weed out some of the operational modules to cut down on the memory requirement.

One thing TOPS has done to sweeten the package is to provide you with its *InBox* e-mail software. Included in the *TOPS Network Bundle for DOS*, it lets PCs and Macintoshes act as nondedicated servers for storing each other's mail. *InBox* contains a long list of features, including multiple windows and password encryption. (If you don't buy the entire *TOPS Network Bundle for DOS*, *InBox* costs $329 per message center.) A full-powered e-mail system called *InBox Plus* supports communications between multiple message centers and up to 100 users.

TOPS/DOS s a highly specialized LAN that fills a specific market niche. For Mac users who want to tap into PC disk technology, or for PC users who want access to Mac resources, this is probably the product to buy. ■

FACT FILE



TOPS Network Bundle for DOS, Version 3.0
TOPS, 950 Marina Village Pkwy., Alameda, CA 94501; (415) 769-9669.
List Price: $249 per node; 10 users, $995. FlashTalk card, $239.
Requires: 640K RAM, DOS 3.3 or later. Optional extended memory recommended.
In Short: *TOPS/DOS* is a leading LAN that bridges the Apple Macintosh and PC worlds. It's a no-frills network in which Macs cannot print to your PCs' printers but PCs can print to AppleTalk-compatible printers and lasers.

CIRCLE 403 ON READER SERVICE CARD

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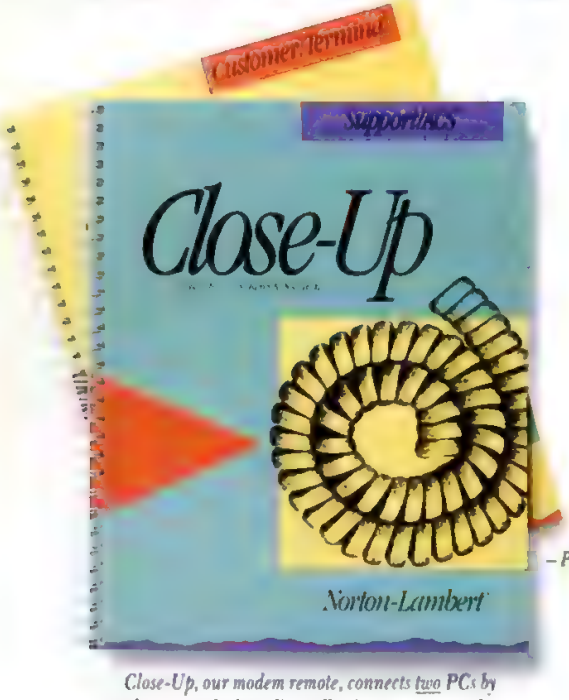
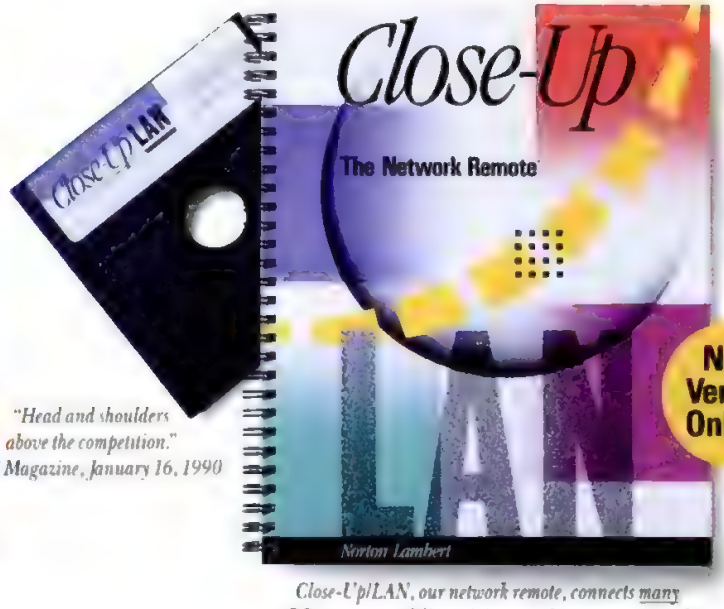
How to Communicate





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– PC Magazine, January 16, 1990

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Close-Up/LAN, our network remote, connects many PCs on a network line, giving you the power to control one, many, or all PCs on your network.

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Awarded PC World's "Best Buy", Close-Up connects two PCs by modem, allowing screens and keyboards to work as one. Two people can see the same thing at the same time.

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3Com	Digital Equipment
IBM	Ashton-Tate
Lotus	Tektronix
Borland	Microrim

Industry leaders who've chosen Close-Up.

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Can LANs Beat Minis?

PC LAN Labs and Price Waterhouse set out to answer the single most important question that developers of large-scale multiuser systems are confronting today.

BY LEE THÉ

The price and the performance of LANs, minis, and Unix-based systems now overlap so broadly that these alternatives are in direct competition for use in many multiuser business applications. LANs in particular have matured to the point where they are competing head-on with minis in applications involving not just dozens but hundreds of workstations—to the point where hybrid forms combining local area networks with minis and Unix systems are rapidly appearing.

THE LAN SURVIVAL GUIDE

Such assertions have been made before. They just haven't been backed up. You can find price/performance comparisons, but only between Novell

and 3Com LANs, or between DEC MicroVAX and IBM AS/400 minis, or between Altos and ALR Unix-based systems. While cross-environment anecdotes and rhetoric abound, hard data has been hard to find. Too bad, because when you're going to bat for the environment of your choice, you want solid figures to prove your point.

That's why we decided to produce a Rosetta-stone performance test, one that would provide a data bridge connecting LANs, minis, and Unix systems. We thought if we could give you direct comparisons between leading examples of each genre, you could then extrapolate to other systems not tested here, making better use of the anecdotal information and qualitative evaluations you read.

Our evaluation process revolves around a suite of accounting-based tests that churn drives and I/O and work the processors. Unlike CPU-intensive benchmark tests, which are more appropriate for testing the suitability of individual workstations for CAD, DTP, and the like, these tests duplicate the mix of system activities involved in the average multiuser business application.

10 NODES OR 100?

By using macros rather than humans to act as our data entry clerks, we were able to load the networks heavily to give you an idea of how they perform in large installations. We timed a data entry expert and found that it took him between 30 and 90 seconds to enter each order. The macro took a consistent 3 seconds.

With that in mind, we can suggest a conservative rule of thumb for comparison: look at the one-workstation performance on the Data Entry Degradation test as simulating only two or three human-operated workstations, because of the lack of contention among users to access the server and get data. The three-workstation part of the test simulates 20 to 30 live users; again the contention is relatively low considering the number of orders going through the system. Five, seven, and ten workstations simulate 50, 70, and 100 workstation users, respectively.

These estimates are conservative in the light of our human/robot order entry comparison, but one incident during our testing helped validate such high multiplication factors. When we were running *Platinum Series* with a client/server option under *NetWare 386* on a $30,000-plus Compaq Systempro server, *NetWare*'s system load monitor was consistently reporting 90 percent CPU utilization during the Data Entry test when we ran it on the maximum of ten workstations. This isn't even a CPU-intensive test—relatively speaking.

Our Sequential and Concurrent Reporting test scores represent the totals of separate timings for ten reports, which work the system in different ways. The customer and vendor aging reports are rather CPU-intensive because the system is generating columns and doing sorts to fill in those columns. The customer and vendor statements are just dumping lists off the disks, so they're fairly pure I/O tests. The others fall in between. This explains some of the discrepancies we noticed among the times needed for different reports.

The central problem in testing the different environments was to find an I/O-intensive multiuser package that ran on LANs, minis, and Unix systems without favoring any of them.

Our last test, Mixed Processing, runs five reports and five workstations at once to emulate typical real-life system utilization. Taken altogether, this varied test suite will let you focus on the tests that come closest to the applications you have in mind for your system.

PICKING SYSTEMS

Test instruments in hand, we began the search for packages that would fit our criteria. The central problem was to find an I/O-intensive multiuser package that ran on LANs, minis, and Unix systems without favoring any one of these.

First we consulted with *Digital Review*, our sister publication specializing in DEC-related news. Its research led us to consider MCBA accounting software, which has a 17 percent DEC VAX market share and products in the LAN and Unix arenas as well. After weeks of dialogue, MCBA chose not to participate. Fortunately, we had a great alternative: the mature and highly stable *RealWorld Accounting System* from RealWorld Corp.

The *RealWorld* software turned out to suit our needs well. It has considerable visibility in both the LAN and Unix environments and, while relatively new to the DEC world, has already gained a 5 percent market share there. It's also an MCBA licensee, and it costs less than other name-brand accounting packages running on DECs: $1,000 per module on small MicroVAXes. This enables you to use it in smaller-scale sites than more "normally" priced DEC accounting software would permit. Lastly, while *RealWorld* isn't fast on any platform, it seems to be equally unhurried on all of them.

We knew we wanted to use *NetWare 386* as our LAN operating system. We next picked two platforms for it: the hot new Compaq Systempro and a sturdy old IBM PS/2 Model 80 with a superfast Core 310MB ESDI hard disk. Both CPUs were run with 32-bit network adapters—EISA for the Systempro and MCA for the Model 80. The Model 80 provided the reality check of a relatively economical 20-MHz 386 server; thus, it was certainly more characteristic of what you're likely to find today than the exotic Systempro.

On the Unix side, the choice of operating system was easy: The Santa Cruz Operation's SCO Unix. SCO has done more work than any other Unix vendor on producing a product suitable for multiuser business applications. In order to make direct comparisons, we used the same Compaq Systempro. On it we installed an Arnet Smartport 16-port, 16-bit serial board and adapter card. Arnet Corp. is one of the most popular multiport manufacturers; it also makes complete PC-based host machines.

A 32-bit multiport adapter card would have helped the Unix times. While that wasn't available in time for our tests, we were able to activate the multiprocessor extension of Unix that lets it use the Systempro's two 386 processors; *NetWare 386* still lacked the two-386 extensions at testing time. It just goes to show that no matter how hard you try, the playing field is never level . . . but at least it's there for the game.

For the minicomputer we settled on a Digital Equipment Corp. MicroVAX using VMS, DEC's proprietary operating system, which runs on everything up to the mini-mainframe 9000. MicroVAXes are used in most comparisons between smaller

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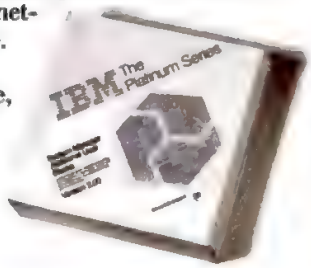

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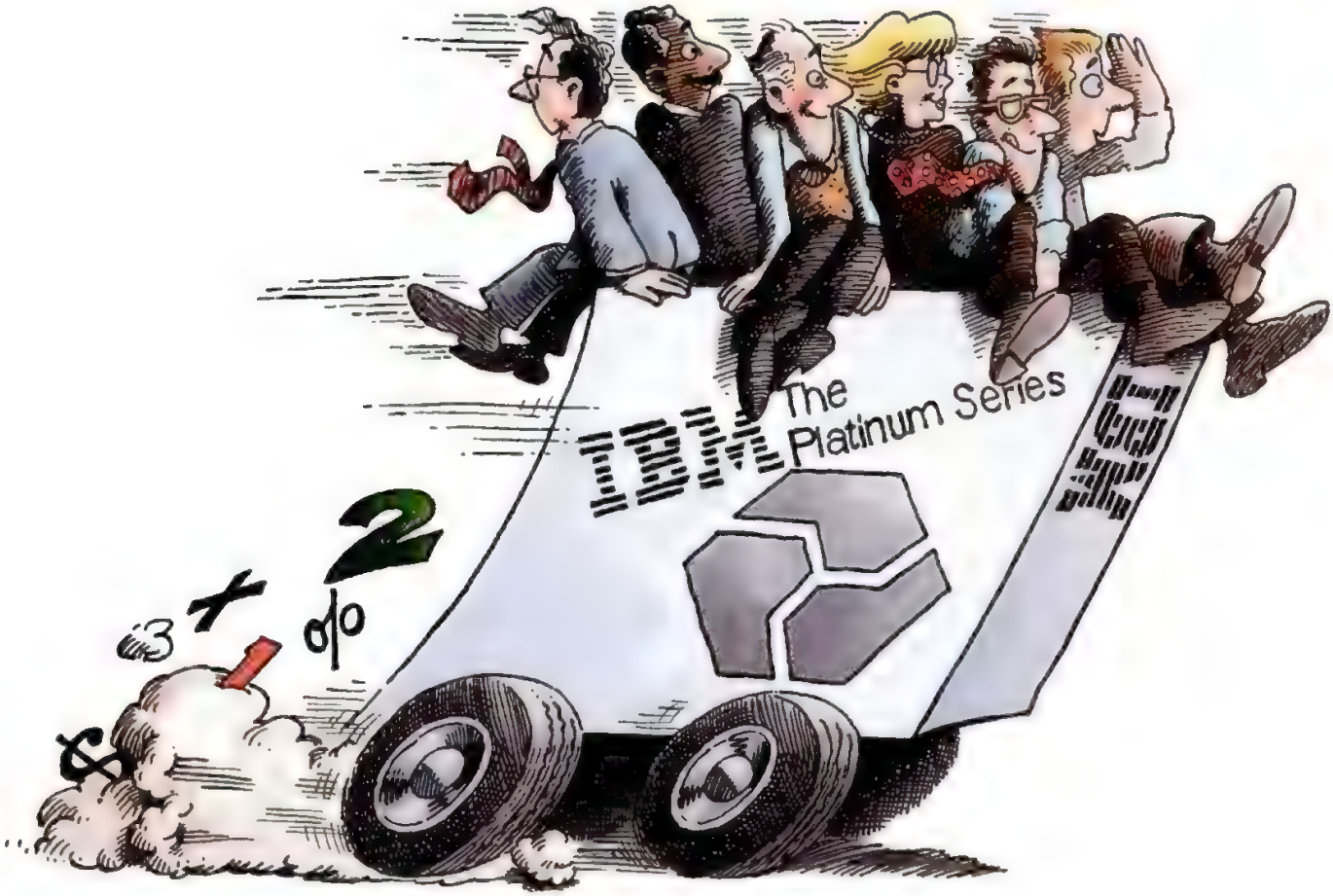

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CIRCLE 494 ON READER SERVICE CARD

THE PRICE OF POWER, THE POWER OF PRICE

by Ray August and Lee Thé

According to *Digital Review*, DEC users measure performance for disk- and I/O-intensive tasks in terms of something called QIOs: random-access queued I/O requests. The standard specification is the number of QIOs per second the system can sustain. A high score indicates that the system moves along without imposing productivity-sapping waits on users working at their consoles.

QIO scores don't measure CPU speed directly, but they do serve as a practical way of judging a system's ability to handle transaction-oriented business activities such as accounting and heavy database updating.

Using our own multiuser accounting tests, we obtained performance figures for the DEC MicroVAX 3100 with two hard disks and compared them with results from three different high-powered PC-based systems: two LANs and a Unix system. From *Digital Review*'s QIO test results, we selected ratings for several representative minicomputers that *Digital Review* felt would be competitive with a 50-user LAN or Unix system.

Using the MicroVAX 3100 as our Rosetta stone, we then calculated QIO ratings for all of our test systems. To plot each system on our price/performance chart, we estimated the total cost for a 50-user installation.

These are only ballpark figures, of course. We haven't taken into consideration such crucial factors as discounts, substitution of third-party goods and services, maintenance, depreciation, and salvage value. Discounts in mini territory appear to be roughly comparable to what is available for Macintoshes, another environment where you can't second-source CPUs. The line separating the areas of better and worse performance was editorially, not mathematically, determined.

Mini maintenance has a reputation for being expensive, but it's gotten cheaper as the hardware has become more reliable. And on-site service for the CPUs and wiring that a large LAN requires is hardly cheap, either. We'll get into this in detail with our forthcoming special issue on service and reliability (September 25, 1990).

BANG FOR THE BUCK

A quick perusal of the price/performance chart shows our Compaq Systempro–based Unix setup the clear winner. The rest of the figures are generally close enough to keep the decision between LANs and minis an entertaining one—and qualitative enough that LAN fans can extol the joys of personal computing without making the CFO wince at the price of those joys.

Indeed, by shopping carefully for third-party items you could chop most of the LAN prices listed here massively, even if you aren't willing to compromise system performance. You would just be wandering farther and farther from familiar brand names. Most of the workstations in our test LAN, for example, were mail-order machines.

You have less pricing leeway with a Unix setup, both because terminals vary less in price than PCs and because acceptable performance on a 50-user Unix system takes a heftier server than a 50-user LAN would need.

LANs may also offer faster software. We used the same accounting software across the board—*RealWorld Accounting System*, a package that isn't particularly fast in any environment—but in the PC arena you can get other good accounting packages that run two to six times as fast (see the sidebar "Adding Up Accounting Performance"). If you can't find equally fast alternatives in the mini environment—and we suspect you can't—that would tip our price/QIO figures strongly in favor of the LANs. Even in the Unix environment most of the accounting packages we've seen do not have a reputation for great speed.

We're looking forward to the next LAN/mini/Unix challenge. We'd love to see how the new IBM RISC box compares when churning transactions through its disks and I/O systems.

Everybody's shooting at moving targets, all right. ■

minis, and choosing it enabled us to do our testing at the offices of *Digital Review* in Boston, with considerable help from DR Labs staffers.

When we approached DEC about the testing, we asked to use its fastest, most powerful MicroVAX, the 3900. DEC, however, chose to supply the most inexpensive MicroVAX in the line: the 3100, albeit with two 104MB drives and 16MB RAM instead of the base model's single drive and 4MB RAM. This machine is touted as being good for up to ten live users, not necessarily the hundreds of simulated ones who pounded it in our tests. As it turned out, we were right in making our original request, but at least the system's performance can easily be compared with that of the other VAX machines.

Ironically enough, the 3100 cost much less than the LAN and the Unix systems we tested. Another irony: our little Micro-

ADDING UP ACCOUNTING PERFORMANCE

by Lee Thé

During the course of our LAN-versus-mini testing, we found out some interesting things about *RealWorld Accounting System*, *Macola*, and *Platinum Series*, the three accounting packages we used as our test instruments.

We also had some revelations about Novell's *NetWare 386* and the Btrieve Network Load Module. This NLM furnishes client/server operation for applications that have been modified to use it. Its performance has a bearing on the other client/server products due for release this year.

THE ACCOUNTING PACKAGES

RealWorld offers strong portability along with weak speed. It can be scaled all the way from a single-user XT up to a large LAN or Unix system, even to a $2 million DEC VAX 9000–based system. *RealWorld* means never having to say "retrain."

RealWorld does trap and track a large amount of data, which can slow processing if not all that data is needed. Since *Platinum* and *Macola* let you turn off the processing of data you don't want, they achieved the fastest times in our tests. When we added up all the reports our Concurrent Reporting test produced, we found that *RealWorld* printed 36.6MB of information to disk compared with *Platinum*'s 30.8MB and *Macola*'s 28.2MB.

Both *Macola* and *Platinum* charge ahead of *RealWorld* when it comes to reporting and data entry speed. That's no surprise if you compare *Platinum*'s two data entry screens with *RealWorld*'s seven. *RealWorld* likewise falls behind in reporting.

Take our Mixed Processing test, which combines order entry on five workstations with report processing on five others. *RealWorld* needed over 2 hours on our IBM PS/2 Model 80, compared with *Macola*'s 43 minutes and *Platinum*'s 34 minutes on the Model 80 or a mere 29 minutes on the Compaq Systempro.

Macola and *RealWorld*, both MCBA licensees, have a similar look and feel. We suspect that much of the speed difference comes from *Macola*'s using the Micro Focus COBOL compiler, while *RealWorld* relies on RM COBOL for PCs and DEC's COBOL compiler for VAXes. Incidentally, their shared ancestor, *MCBA*, accounts for 17 percent of all DEC-based accounting installations, according to *Digital Review*.

RealWorld was excellent for testing across various platforms, but that package is by no means the fastest PC-based multiuser accounting system.

Concurrent processing of ten reports told a similar story. On the Model 80, *RealWorld* took over 7 hours compared with *Macola*'s 2.5 hours and *Platinum*'s 1.5. And in a ten-user concurrent order entry test (not on the chart), we clocked *RealWorld* at 2 hours, as opposed to 45 minutes for *Macola* and just over 1 hour for *Platinum*.

If *RealWorld*'s speed is representative of what is available on minis, then to match the average speed of *Macola* and *Platinum* you'd need a mini at least two to six times as fast as what our comparison calls for.

NOVELL PROPOSITIONS

Which yields better file access times, Novell's Btrieve or COBOL? *Macola* comes in both flavors, so we tested them both on the Compaq Systempro.

In that environment, COBOL was slower in reporting but faster entering data when we experimented with three or more concurrent workstations. The difference increased with load, too. So if we were doing a lot of data entry we'd certainly pick *Macola*'s COBOL flavor. This is not conclusive for other systems, but it does show how old dogs may still have good legs.

Conversely, Btrieve seemed fast on reads, slow on writes. Of course it has other benefits compared with COBOL, including the *Xtrieve* report writer and such productivity tools as *Magic PC*, a database development program from Aker Corp.

How about normal Btrieve-based processing compared with the client/server NLM? Our limited testing with *Platinum* on the Compaq Systempro clearly showed that the client/server NLM shares some of the advantages and disadvantages of pure host-based systems such as Unix.

The NLM blazed along on the Data Entry tests. It nearly triples the speed of *Platinum* with ten workstations entering data, but slows it down by 25 percent on Mixed Processing. So you have to make a choice—or use the NLM only when you need it. That means rebooting the server.

The problem is that the NLM uses the server's processor heavily. That's the idea of the NLM: to use an expensive file server's CPU more, and to cut

CONTINUES

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VAX was smaller and lighter than a typical AT. Anyone short of Hulk Hogan who tried to pick up a Compaq Systempro, on the other hand, might get a hernia.

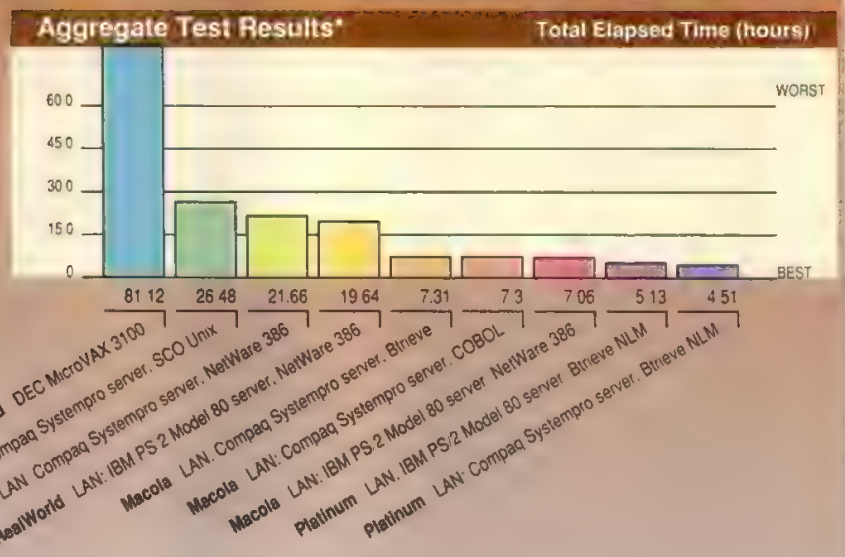
GETTING TO WORK

We tested the DEC with 19.2-kilobit-per-second DEC terminals. For our LAN and Unix workstations we used five 286s and five 386s from various vendors—a setup similar to the kind of hodgepodge that most of our readers say they have in their offices.

Those CPUs' considerable aggregate horsepower didn't enter into the Unix testing, of course. We just used terminal emulation software to punch keystrokes out of the serial ports at 9,600 bps. We wondered whether using 9,600 bps instead of higher speeds might affect the results, but if there had been a bottleneck, performance would have degraded in a linear fashion as we

PERFORMANCE TESTS: LAN-BASED ACCOUNTING SOFTWARE

***RealWorld Accounting System* offers strong portability along with weak speed, while *Macola* and *Platinum Series* both demonstrate how fast a PC-based multiuser accounting system can be.**



* The charted numbers represent the sum of all five test scores for each configuration. Discrepancies between these numbers and the results in the table below are due to the rounding of the test scores.

Performance Times
(Times given in hours)

Accounting package	Environment	Mixed Processing	Sequential Data Entry	Concurrent Data Entry	Sequential Reporting	Concurrent Reporting
RealWorld	DEC MicroVAX 3100	12.09	3.62	24.95	8.29	32.16
RealWorld	Unix system: Compaq Systempro server, SCO Unix	3.60	1.96	8.12	1.68	11.11
RealWorld	LAN: Compaq Systempro server, NetWare 386	2.19	1.77	5.46	4.05	8.19
RealWorld	LAN: IBM PS/2 Model 80 server, NetWare 386	2.03	1.71	4.79	3.98	7.13
Macola	LAN: Compaq Systempro server, Btrieve	0.89	0.77	2.59	1.25	1.82
Macola	LAN: Compaq Systempro server, COBOL	0.71	0.66	1.81	1.54	2.58
Macola	LAN: IBM PS/2 Model 80 server, NetWare 386	0.71	0.65	1.72	1.45	2.52
Platinum	LAN: IBM PS/2 Model 80 server, Btrieve NLM	0.56	0.23	1.69	1.12	1.52
Platinum	LAN: Compaq Systempro server, Btrieve NLM	0.48	0.26	1.28	1.12	1.37

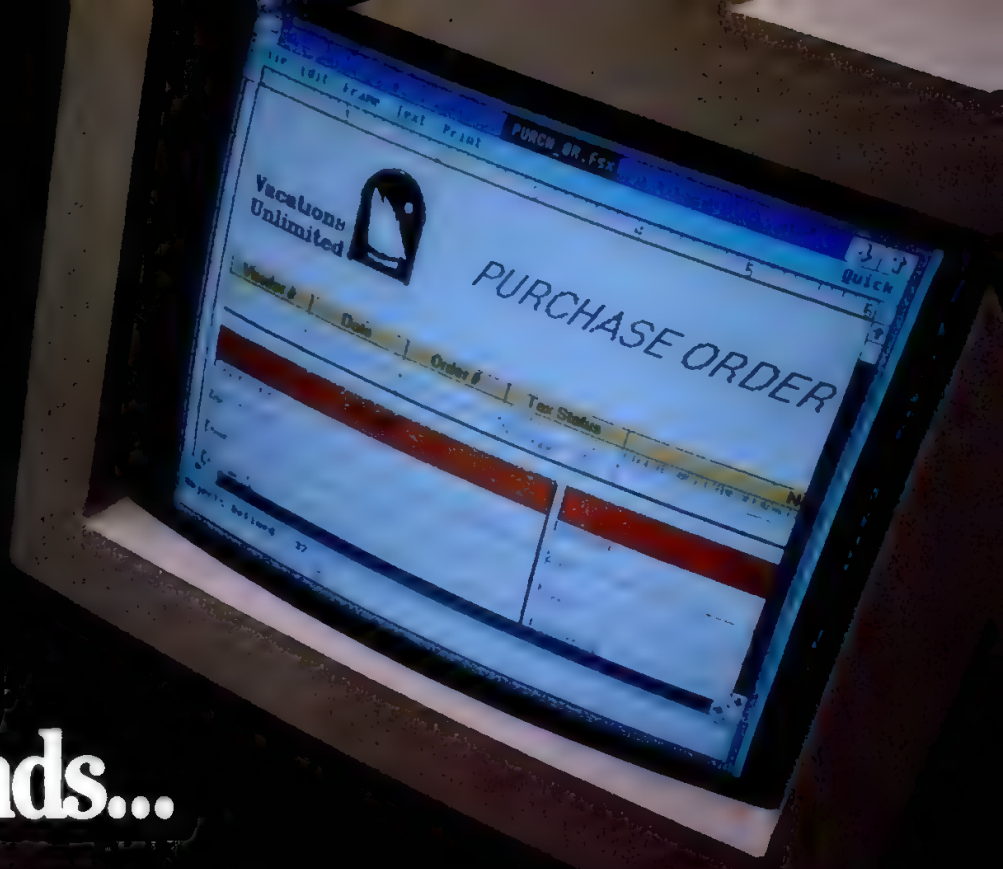
CONTINUED

down on network traffic by digesting requests to the central database more than conventional server operation would permit.

Under the relatively light server CPU load of data entry, this process works great: it saves Btrieve from the wall it seems to hit with many workstations running. Add CPU-intensive processes such as multiple or complex reports, however, and you're going to need the second 386 chip Compaq offers for the Systempro. As soon as *NetWare* is upgraded to take advantage of it, that is.

Try this as a start for your own thinking: On a smaller LAN—say, with less than a dozen workstations—consider getting a very fast server and relatively weak workstations, then run the NLM to get the most out of that server. On a LAN with dozens of nodes, consider equalizing the horsepower of server versus workstations and implementing a distributed processing scheme.

What we really need is dynamic load balancing among all the processors on a LAN, regardless of its size. Some call this the cooperative processing model: a bunch of networked 386s sharing both memory and clock ticks to provide maximum allocated processing power at all times. Using this model will require a high degree of intelligence on the part of the operating system, since it will have to know when to hold and when to fold. That's what it will take to tackle the bigger minis, and today's Novell client/server NLM is a step toward that goal. Nothing more, nothing less. ■



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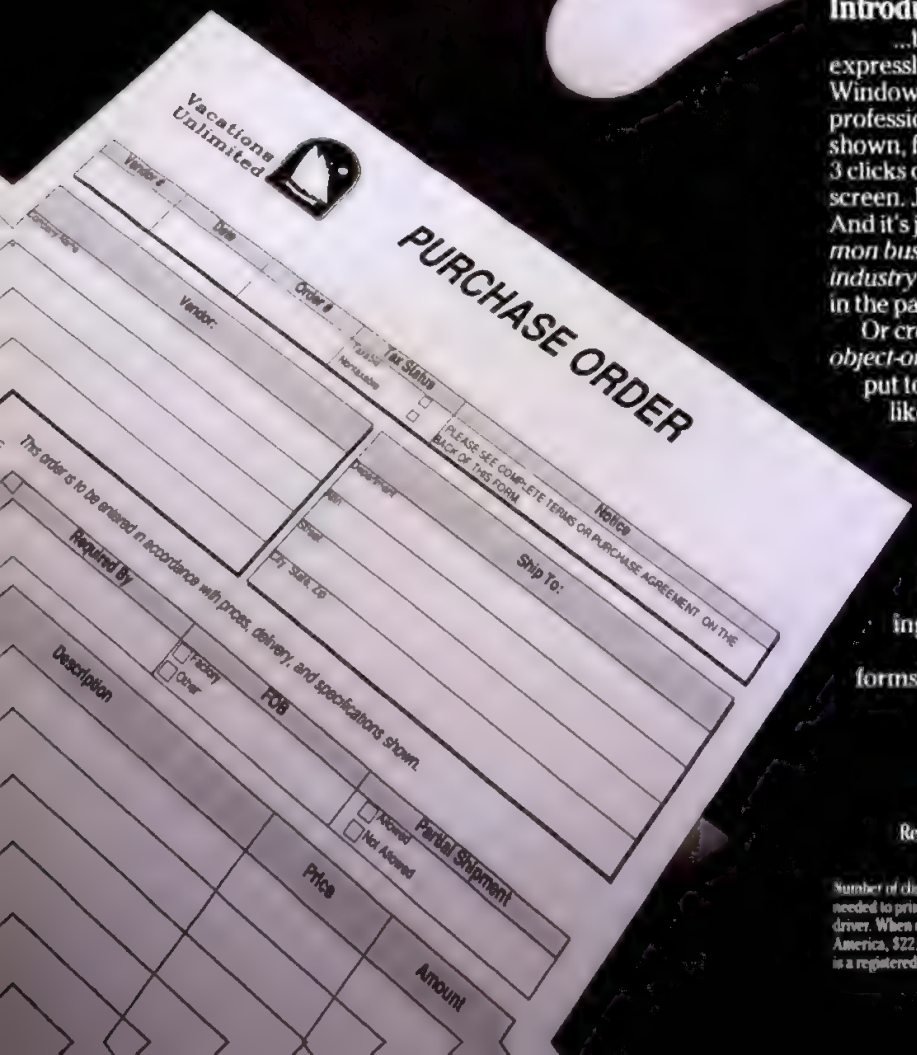

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CIRCLE 174 ON READER SERVICE CARD

LANs VS. MINIS: How the Tests Were Run

by Raymond A. August

When we compared multiuser accounting packages (*PC Magazine*, September 26, 1989), we realized that the tests we had designed didn't test just the software but also revealed many things about the hardware by exercising the processor, the hard disks, and the bus.

While planning for LAN-versus-mini testing, we decided to forgo all the usual measures of system performance (such as mips). Instead, we brought back the multiuser accounting performance tests, reworked them, and (unlike our procedure last fall) kept the software constant while we changed the hardware platforms.

We also made the tests tougher because we wanted to compare Intel-based platforms running *NetWare* and SCO Unix against powerhouse MicroVAXes. To do this, we started with a subset of the original tests that had proved to be especially revealing: straight data entry on progressively greater numbers of workstations; producing reports based on the data entered; and performing each of these tasks with concurrent workstations creating contention on the network.

To exercise the hardware further, we increased the number of workstations used for all concurrent tests from five to ten and added a Mixed Processing test that simulates how real organizations really operate: five stations entering data, five simultaneously printing reports.

RealWorld Accounting System was the one multiuser accounting package we could test across all platforms; it has versions for the DOS, Unix, and VAX worlds. It allowed us to minimize our variables, with one minor exception: *RealWorld* uses the Ryan McFarland COBOL compiler in the DOS and Unix arenas and the VAX COBOL compiler on the DEC platform.

We loaded *RealWorld* with a database that included 10,000 inventory items, 2,000 vendors, 5,000 customers, and 46,000 general ledger detail items. We then added 1,200 orders with our order-entry macros. This data produced a database of over 70 megabytes. Without such a database we could not have exercised the system as seriously as we did.

We gathered ten workstations that represent the mix you see in many organizations today: one 33-MHz, one 25-MHz, and three 20-MHz 386s; one 20-MHz 286, and four 12-MHz 286s. Four different manufacturers were represented. Each station was equipped with a 16-bit 3Com 3C503 adapter card, connected via thin Ethernet to the file server.

With *NetWare 386* as our operating system, we picked two server platforms: the first, a Compaq Systempro with 8MB RAM and a Novell 32-bit EISA adapter card; the second, an IBM PS/2 Model 80 with 8MB RAM, a Novell 32-bit Micro Channel adapter card, and a superfast Core 310MB ESDI hard disk.

Unix testing was conducted on the Systempro with SCO Unix and the same workstations used in the LAN testing.

> Rather than gauge performance with the usual measures like mips, we ran our accounting tests.

At DEC's suggestion, we tested a MicroVAX 3100 with 16MB of memory, running VMS. We used DEC VT200 terminals communicating at 19.2 kilobytes per second to DECServer 200 terminal servers running over an Ethernet network. For the MicroVAX—unlike the LAN or Unix server, which used workstation-resident keyboard macro programs—we used *PSS* software that processed on the host to generate our keyboard macros.

LAN and Unix testing was conducted at PC LAN Labs. The *PC Magazine*/Price Waterhouse testing team then flew to DR Labs at *Digital Review*, where the MicroVAX system was configured and loaded by representatives of DEC and RealWorld Corp. All timing was conducted by Price Waterhouse personnel and verified by *PC Magazine*.

CONTINUES

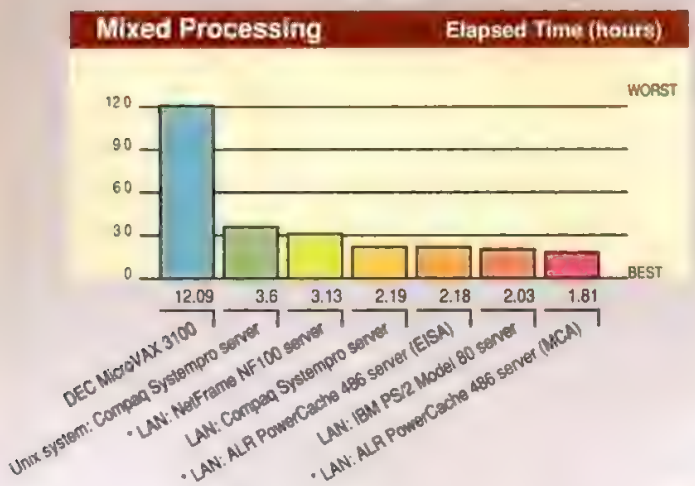
THE TESTING TEAM

PC Magazine's multiuser accounting test suite was designed by Price Waterhouse representatives Raymond A. August and Timothy J. Lee. Testing was supervised by August, Lee, workgroup systems editor Frank J. Derfler, Jr., project leader Randol Tigrett, and senior west coast editor Lee Thé. *PC Magazine* gratefully acknowledges the work of the following people, who spent hundreds of hours conducting these performance tests.

Greg Angus, product assembly director, RealWorld Corp.
Bruce Hollinger, president, Macola Inc.
Timothy J. Lee, CSP, director of information services, Quincy Soybean, and former consulting manager of Price Waterhouse.
Rick Mardis, software portability manager, RealWorld Corp.
Kevin McGuirk, director of communications, Advanced Business Microsystems Inc.
Mark Mewhorter, manager of product development, Macola Inc.
Steve Owens, CPA, consulting manager, Price Waterhouse.
Kevin Riegelsberger, executive vice president, Advanced Business Microsystems Inc.
Lee G. Schlesinger, project leader, DR Labs, *Digital Review*.
Greg Schwarzer, technical marketing engineer, The Santa Cruz Operation.
Thomas White, consulting manager, Price Waterhouse.
David Wood, system specialist, AT&T.

PERFORMANCE TESTS: LANs VS. MINIS

In this suite of multiuser accounting tests, the clear overall winner is the LAN, specifically (and surprisingly) the LAN powered by the 20-MHz IBM PS/2 Model 80 with its 32-bit Novell adapter card and ultrafast Core ESDI hard disk.



The **Mixed Processing** test is the most indicative of a day-to-day accounting environment, combining both data entry and reporting. Five workstations enter orders concurrently while the other five print reports concurrently.

To show how the NetFrame NF100 competes in this arena, we have included results for it here (for more on this product, see "The Super Servers" in this issue). Also included are results for two 486 servers: an ALR PowerCache 486 with an EISA bus and an ALR PowerCache 486 with an MCA bus.

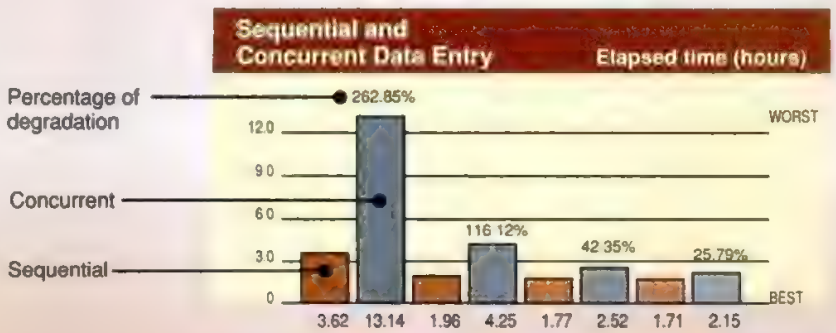
The **Sequential Data Entry** test shows the speed of entering orders from ten workstations one workstation at a time, and the **Concurrent Data Entry** test represents all ten workstations entering orders simultaneously. Each station enters 30 orders, each order consisting of five line items.

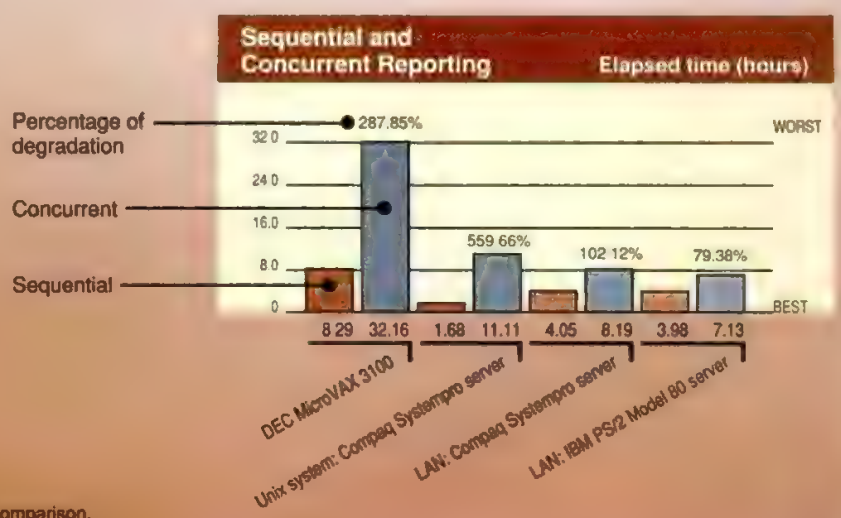
Performance degradation between the sequential and concurrent tests has also been calculated.

To test the speed of **Sequential Reporting,** we requested ten reports from ten workstations. Requests were sent to the server sequentially, one workstation at a time. Then, to gauge how well each system handles the increased contention of **Concurrent Reporting,** we requested all ten reports simultaneously. In contrast to our Concurrent Data Entry test, which simulates the typical workload of approximately 100 users, this test simulates exactly ten users, since it is not uncommon to have ten users printing reports simultaneously.

The reports call on the resources of several accounting modules, including General Ledger, Accounts Payable, Accounts Receivable, and Inventory. These are typical of what a business would require on any average day.

Performance degradation between the sequential and concurrent tests has also been calculated.





* Reported for comparison.

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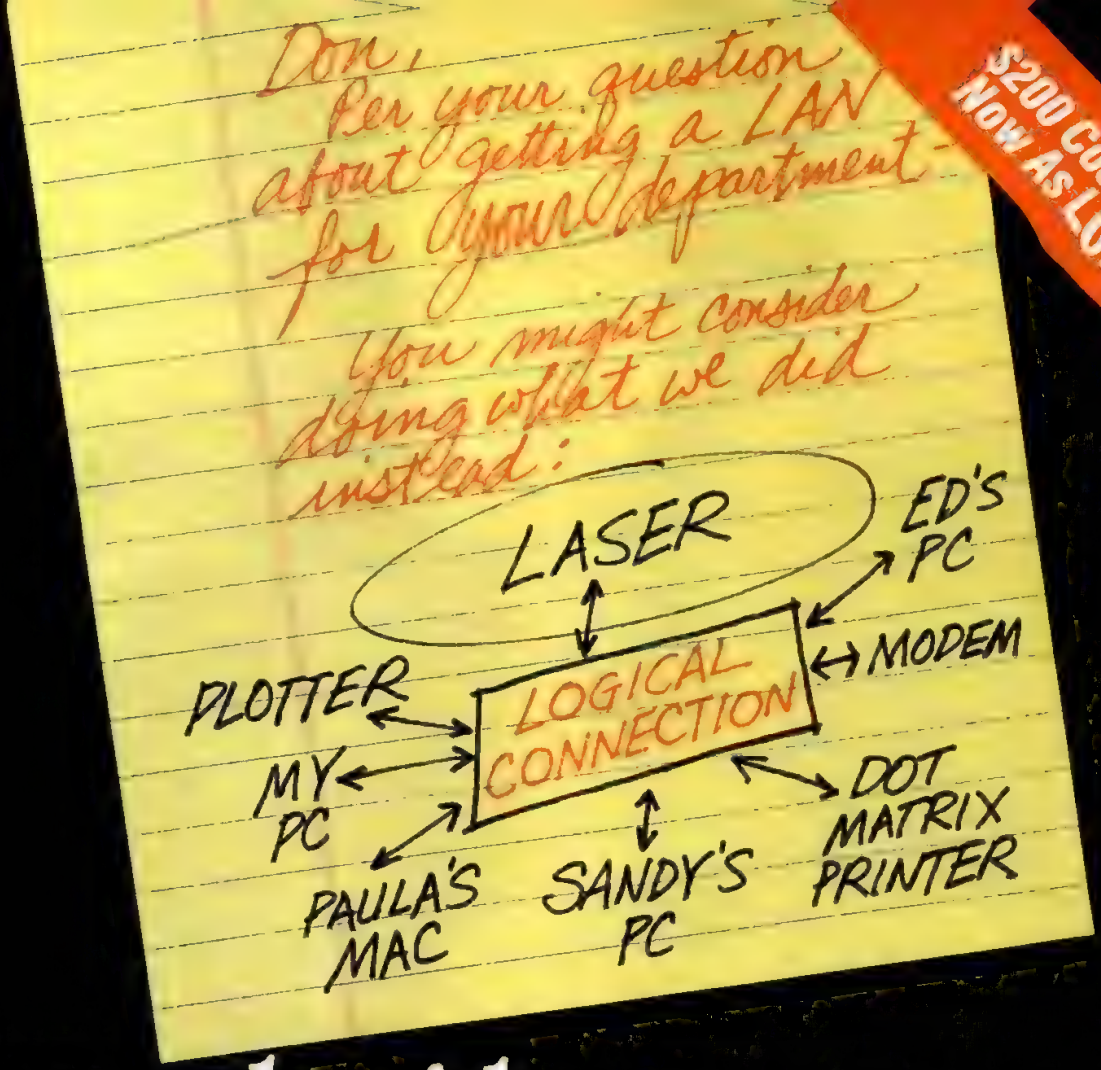

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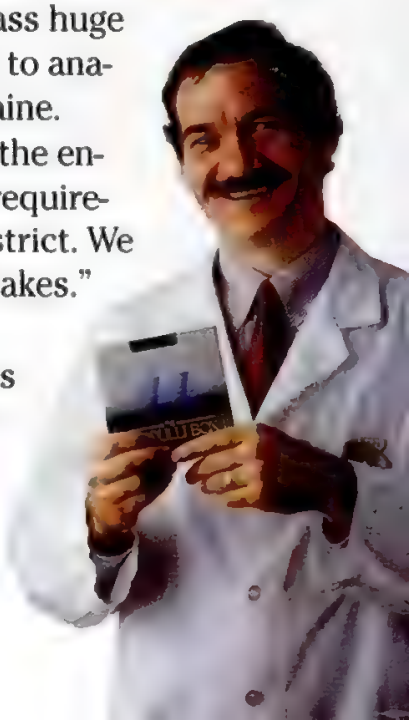

Don Fontaine
Project Leader
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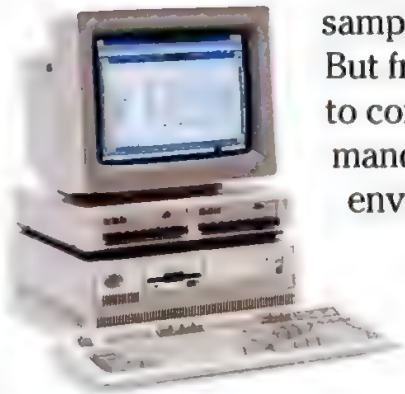
"Bernoulli is a complete storage solution," he continued. "Without it, I'd be resigned to less sophisticated sample analysis packages. But frankly, I wouldn't want to compromise my performance at the expense of the environment."



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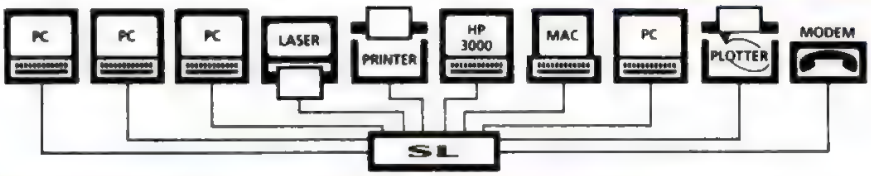

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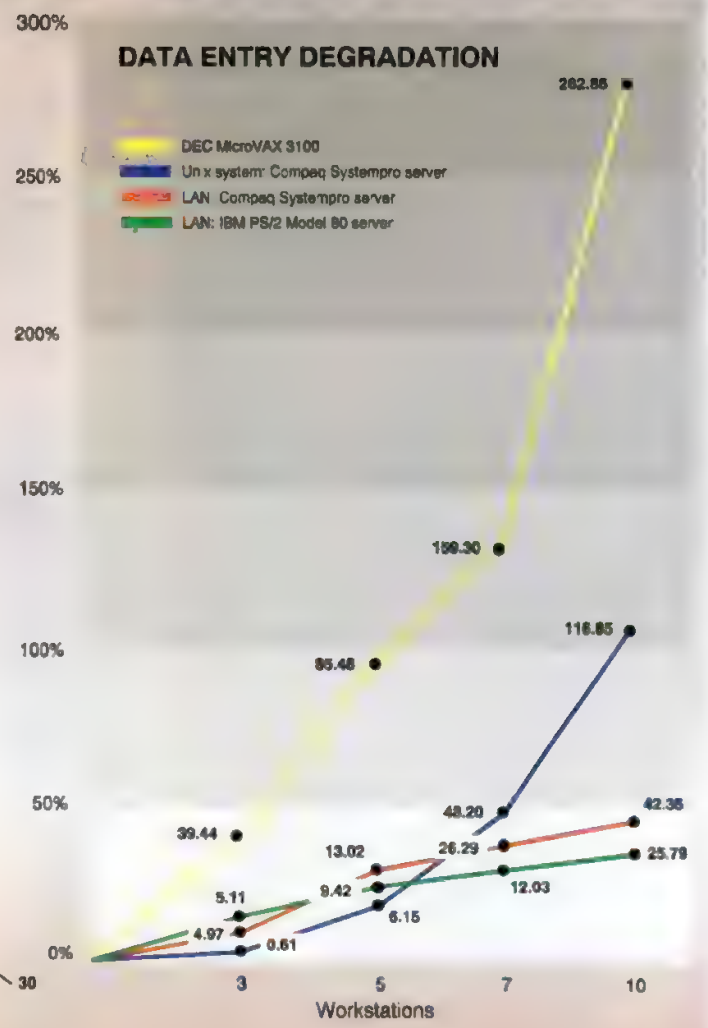
COMPOSITE VIEW: LANs VS. MINIS

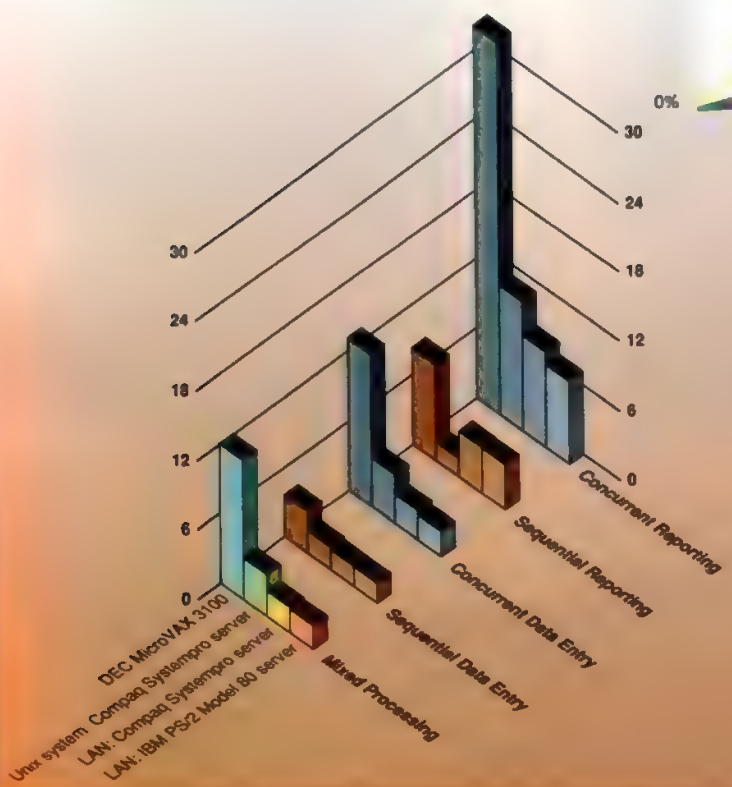
The clear overall winner in this suite of multiuser accounting tests is the LAN, specifically (and surprisingly) the LAN powered by the 20-MHz IBM PS/2 Model 80 with its 32-bit Novell adapter card and ultrafast Core ESDI hard disk.

Both of the LANs really began to shine as we added more simultaneous data requests or, in the case of the Data Entry tests, more users. The Unix system performed admirably; especially when running our reports without contention, it was more than twice as fast as either LAN. But as we added users it began to slow down quickly, registering the largest percentage of degradation among all the systems tested.

In a distant fourth place was the DEC MicroVAX 3100, taking four and a half times as long as the PS/2 LAN to complete the Concurrent Reporting test. Its Concurrent Data Entry performance, which took six times as long as the LAN, really demonstrates the advantages of a LAN's distributed processing capabilities.



Performance Times
(Shorter bars represent better performance)



The **Data Entry Degradation** test shows what happens to a system when you incrementally add users who are entering orders. We first timed the entry of 30 orders on each type of station under single-user conditions. We then increased the load to three, five, seven, and ten stations, with each station simultaneously adding 30 orders. Degradation represents the time difference between individual operation and operation under contention, expressed as a percentage of the former timing.

Although we did not go beyond ten workstations, we estimate that these ten did the work of 75 to 125 real-world concurrent workstations in terms of the number of transactions per minute.

ENDS

added more workstations, and that did not happen.

With everything selected, we marshalled vendors, products, staff, and resources and went to work. Overall, the test results were deceptively simple. The little MicroVAX 3100 was flattened by our high-powered LAN and Unix systems in nearly every dimension of our performance testing. The Unix setup won the Sequential Reporting test but it got bogged down under heavy loads. The costlier, more complex Systempro LAN won every test that took place under any kind of multiuser load.

THE MICROVAX

Not only was the MicroVAX 3100 with its disks and peripherals DEC's own choice for this evaluation, but to make sure things ran as smoothly as possible, company representatives came in to install and tweak the system.

The MicroVAX 3100's slowness was surprising. DR Labs used a *PSS* host-based macro program, and we first thought that perhaps the overhead it consumed might have affected the speed, but then considered that macro programs generally do not take up a lot of overhead.

More important, the pattern established by the slow Data Entry results was echoed on the CPU-intensive Sequential and Concurrent Reporting tests, neither of which used macros. Note that the latter test also fairly represents the ten-user load for which the MicroVAX 3100 is targeted, yet even here it took four and a half times as long as the Model 80–based LAN, and nearly three times as long as the Compaq Systempro/Unix scheme. For example, on the Year-to-Date General Ledger report, which balances CPU and I/O loading, the 3100 took over 3.5 hours, compared with 35 minutes on the IBM PS/2 Model 80 LAN and 108 minutes on the Systempro/Unix setup.

These results seemed to indicate that you'd need a VAX with three to five times the overall power of the 3100 (like a VAX 6000 System Model 410 or 420) to match our other systems. However, a DEC representative said he thought a bottleneck might exist with the 30-millisecond, non-intelligently coupled 105MB drives (the *RealWorld* code ran on one drive and the data files on the other). He suggested the solution might be a MicroVAX 3800 with DEC's smart Q-bus (which the 3100 lacks), a pair of fast 400MB hard disks, and 32MB of RAM. Even the 3100 with some fast hard disks—possibly third-party units—might do the trick. Since *RealWorld* comes as a flock of executable files and data files, all with pathnames, they could easily be distributed across as many as six drives even without the Q-bus.

We also speculated that the slowdown in the model we tested could be the result of the VMS operating system, which originated on much larger-scale hardware platforms. DEC does offer one other operating system, its proprietary Unix-type Ultrix, but it wasn't made for business applications (SCO hasn't ported its Unix to the DEC computers).

Digital Review reported that the VMS SCSI drivers and SCSI terminator might be the problem. The technicians in the DR Labs did their own tests on a set of third-party drives, drivers, and terminators from an established vendor named Trimarchi, and these did speed things up considerably on a different model of MicroVAX (which, however, originally came with the

same SCSI setup as our test unit).

All this doesn't mean that there is no place for the tested system, which ran reliably throughout. It represents an economical way to run daughter applications to those on larger VAXes out at remote sites or in workgroups. As long as applications are scaled to its capabilities, it won't produce unconscionable waits for users. The tested system also beat the LANs in running customer and vendor reports sorted by ID (with both sorts on primary keys). Most of the other sequential report times weren't too shabby, either; the only exception was for the most CPU-intensive test, the customer aging report. There, the 3100's tongue hung out shamelessly as it lagged behind the rest.

In general, MicroVAXes with VMS are among the most popular minis, and numerous applications are available for this mature environment. Now it can also support LANs and terminal operation simultaneously. That's welcome news for anyone with a prior VAX commitment who needs more power out at the workstations. You can even stay with a single vendor, since DEC markets its own versions of Tandy personal computers.

The SCO Unix operating system's aplomb was visible in the ease of getting it up and running; in this respect it compared quite favorably with *NetWare*.

HOW ABOUT UNIX?

The SCO Unix operating system's aplomb was visible in the ease of getting it up and running; in this respect, it compared quite favorably with *NetWare*, especially the notorious *NetWare 286*. The Arnet multiport board also installed without a hitch.

You can do only so much with one processor—or even, in this case, with two. On the Reporting tests, Unix's percentage of performance degradation under progressively greater loads exceeded even that of the MicroVAX 3100, though it would take far more load than we imposed for the actual processing speeds to cross.

The Unix setup did fine on up to five test workstations. But at seven workstations, it started sucking wind. At the ten-workstation load represented by the Concurrent Reporting test, its aggregate time was a full 35 percent longer than the score on the same Systempro under *NetWare 386* with half as many processors in use.

In general, the Unix system suffered in comparison with the LAN setup when CPU-intensive reports were run, while it did its best at the same key-indexed sorting reports the 3100 excelled at.

Both host processing systems—MicroVAX and Unix—did worst on reporting during the Mixed Processing test. This indicates that disk I/O penalized these systems more than order processing, which didn't rely on disk I/O as much; rather, it tested processing and the transfer rate through the bus.

Recently, the finest names in networking were put to the test.

This makes sense, as it shows the underlying limits of host processor–based computing versus the powerful complexity of multiple processors wired together over a network. For example, the standalone and concurrent reports were each run by a different workstation on the LAN; the difference in speed between the LAN and Unix setup generally correlated with the speed of the processor on the workstation running the particular report. This was true except for the Dell 20-MHz 286, which ran the standalone reports even faster than several of the 386s (which varied from 20 to 25 to 33 MHz). The results may also reflect the fact that we're still running modified segmented-memory-based 8088 code on 386s most of the time.

SURPRISE IN THE LAN ARENA

Our biggest surprise in the LAN test was that the 20-MHz 386 IBM PS/2 Model 80 beat the Compaq Systempro (running on one 25-MHz 386 processor) in nearly every one of our tests. For corroboration, we ran the Mixed Processing and Concurrent Reporting tests on a brace of nearly identical 486 towers from Advanced Logic Research (ALR), one with an MCA bus, the other with EISA. The winner was the MCA bus, which was faster in every instance, with the EISA bus taking about 20 percent longer overall.

Too many users are still acting as if they're buying a host-based system when they buy a network, when they would get better throughput from a more distributed investment.

Too many users are still acting as if they're buying a host-based system when they buy a network. They get a fancy new 486 tower and then force it to drag around all those clunky old ATs they couldn't stand to chuck, when they would get better throughput from a more distributed investment. That said, we should point out that when we put the MCA version of ALR's PowerCache 486 on the network as the server, we recorded impressive Mixed Processing times; by contrast, the PS/2 Model 80 took 12 percent longer and the Systempro 21 percent longer. The ALR 486 EISA machine ran the same test at almost exactly the same throughput speed as the Systempro EISA machine. We concluded that perhaps the MCA bus allows greater throughput—at least under the stiff system loads we were imposing. Or perhaps MCA card technology, being some years older, has been refined more.

If the Model 80 was a faster LAN server than the Systempro, the tables would probably have been turned if we'd compared them under Unix. In a host-intensive environment, the Systempro's disk array and faster processor (faster by 13 MHz) would confer far more advantages than on a LAN file server. We did some limited testing on a Unix-based Mitac Series 500 with three 386s (a machine that lacks Compaq's re-

In LAN Magazine's famous Drag Race, over forty LANs ran flat out in a contest of speed

*Total test field comprised 47 entrants.

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fined disk array architecture), and the Systempro hammered it.

Our results shouldn't lead you to believe that the Systempro is a dog on a LAN. LANs with client/server architectures will be using the server's CPU far more intensely. Glance back at our experience with the Btrieve NLM pushing the Systempro up to 90 percent utilization of one processor (see "Adding Up Accounting Performance"). If we'd added another application to the server—such as a print or communications server—or more workstations, the CPU would have become the bottleneck instead of the bus and I/O, and performance would have plummeted.

Even in such cases, the bus and drives still count. We think that's why we saw only 10 percent performance improvement when using two processors instead of one on the Systempro under Unix when we ran the Concurrent Data Entry tests. The extra CPU couldn't speed up the 16-bit multiport adapter on the EISA bus.

Such a new box as the Systempro will need much software fine-tuning before we really know what it's capable of doing. All we can say now is that software mainly built for older designs seems to do about as well on those older models.

WHAT IT ALL COSTS

When you're living with a budget, you have to consider not just the performance of these systems but the ultimate cost as well. A glance at the prices will help you see why Unix is doing so well, and why LANs can be hard to sell unless you can show people really making use of all the horsepower on their desktops.

Microcomputers. The ten-user DEC MicroVAX 3100 we tested lists at $31,196, installed on site with all operating system software and hardware, plus perhaps $10 per terminal for RJ11C serial cables. The price includes a one-year carry-in service warranty; an on-site warranty adds $1,739 for the first year and $185 a month thereafter.

If you swapped in Trimarchi hard disk systems, Clearpoint Research Corp. memory, and TRW on-site service, you could save quite a bit: $2,700 on the memory and $2,100 on the drives (assuming you could get DEC to sell you a 3100 sans drives). TRW generally charges 80 percent of what DEC does for service—and supports the third-party products listed here. So you might be able to get your basic setup for as little as $26,396. Using good non-DEC terminals could bring the price down even farther, to about $25,000.

If you need to increase the capacity beyond ten users, you'd have to pay $5,000 more for the extension to your VMS software license and lay out roughly another $2,800 for a multiport board.

As DEC argued, our test load was more like that of a 50-user system than a ten-user one. It's only fair to note the price of its 50-user MicroVAX 3800 with two 400MB drives and 32MB RAM: $160,486. Again, you could effect savings via third-party drives, memory, terminals, multiport terminal concentrators, on-site service, and the like. But if, as we suspect, it takes a VAX 6000 to match our test LAN's performance, you'd be starting with a $1,200,000-plus base price for the CPU and operating system software licenses alone.

A 50-user LAN using DEC 16-MHz 386 PCs with no hard disks and the Com-

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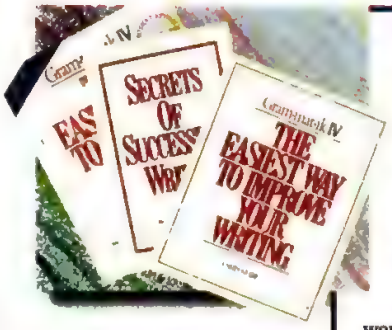

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paq Systempro server would cost about $184,000, which is $24,000 more than DEC's comparable 3800 series MicroVAX. On the other hand, a LAN with 50 name-brand IBM-compatible 386SXs with 1MB RAM and 40MB hard disks (such as the Zeos 386SX-16, a *PC Magazine* Editor's Choice) and a Compaq Systempro would cost somewhat less than the DEC MicroVAX 3800.

The MicroVAX 3100 tested here seems bested by the other host-based systems on a pure price/performance basis. It has its place, to be sure, but perhaps not in open competition with the Unix boxes. Of course, you could also run PCs on desktops and do what we did in the Unix test—link them to a host via terminal emulation. You can even get DEC-and-PC-compatible keyboards for your PC, along with terminal software from KEA Systems (Vancouver, British Columbia) to make the terminal emulation especially painless. That might be a good way to combine PC processing power with larger-system applications.

Unix systems. Our Unix system running on the Model 80 with the Core hard disk would cost $21,000 complete with the Arnet multiport adaptor, SCO Unix, and ten good Wyse terminals; this price configuration includes everything but the serial lines. As with the DEC, you could save with third-party memory, cheaper terminals, and the like. Overall system cost would increase in a linear fashion, except that you would have to spend $2,100 for another multiport adaptor when you exceeded the 16-terminal limit.

Running Unix on the Compaq Systempro would add $17,000, for a total of $38,000. A Systempro-based 50-terminal system would end up costing about $60,000—around a third of the total cost of a 50-node LAN or DEC MicroVAX 3800 system.

LANs. The price of the LAN is the most difficult one to figure out, since it has the most variables. With the Model 80 as the server and ten name-brand IBM compatibles as workstations, figure about $47,000, a price that includes a $7,995 *NetWare 386* license and $1,300 for the 32-bit Ethernet adapter. These prices don't include the additional cost of hard disks on the workstations; they weren't used in our tests, and they aren't required by the network. You can add $5,000 to the system cost if you want them. Once again, swapping in the Compaq Systempro would add $17,000 to all this, for a grand total of $64,000.

Cost for on-site service would almost certainly be higher for the LAN than for the MicroVAX system because of all the CPUs involved, but it might be easier and cheaper for users to maintain their own equipment thanks to the relative simplicity of individual PCs and the possibility of troubleshooting a malfunctioning one by simply swapping parts out until the thing works again.

The bottom line: compared with typical host-based systems—or certainly with Unix—a LAN costs more to buy and install and possibly to maintain as well, but it also does more, is inherently more resistant to performance degradation from adding users or tasks, and permits cooperative processing models that would make full use of the network's distributed horsepower. LANs can also now be combined with host-based systems to create mixed sys-

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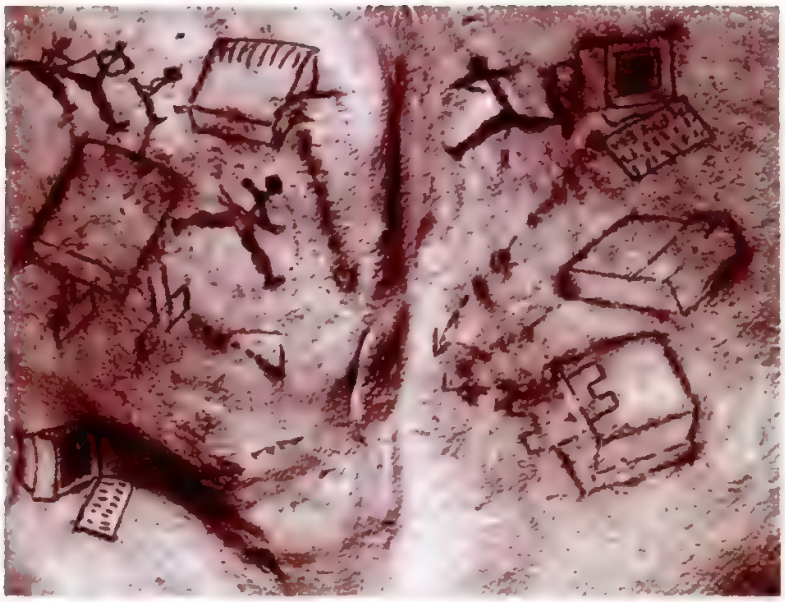

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tems that might provide the best of both worlds.

Overall price scale. For comparison, in round figures, here's how the network prices stack up for ten-user systems (with *NetWare 386* on the LANs and SCO Unix on the Unix systems):

- $21,000: IBM PS/2 Model 80–based Unix system.
- $24,000: All-Zeos LAN with 25-MHz 386 server with 5MB RAM and a 400MB hard disk, eight 386SXs, one 20-MHz 386 with a 40MB hard disk drive, one 25-MHz 386 with an 80MB hard disk drive.
- $25,000: DEC MicroVAX 3100 with as many third-party peripherals as possible.
- $31,000: MicroVAX 3100 with all-DEC equipment.
- $38,000: Compaq Systempro–based Unix system.
- $47,000: Model 80–based LAN with workstations comparable to our test LAN.
- $64,000: Systempro-based LAN with workstations comparable to our test LAN.
- $96,000: Systempro-based LAN with all-Compaq workstations of same speed and processor as our test LAN.

And for 50-user systems:

- $60,000: Systempro-based SCO Unix setup.
- $100,000: All-Zeos LAN with 25-MHz 386 server with 8MB RAM and 800MB hard disk drive, plus 50 386SX nodes.
- $128,000: MicroVAX 3800 with as many third-party peripherals as possible.
- $160,000: Microvax 3800 with all-DEC equipment.
- $226,000: Systempro with 50 Compaq Deskpro 286 workstations (monochrome display, no hard disk drives).
- $282,000: Systempro with 25 Deskpro 286 and 25 Deskpro 386/20 workstations.

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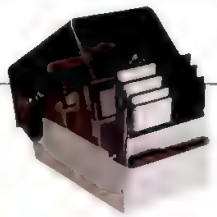

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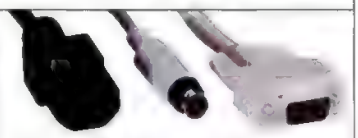

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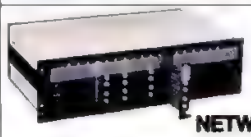

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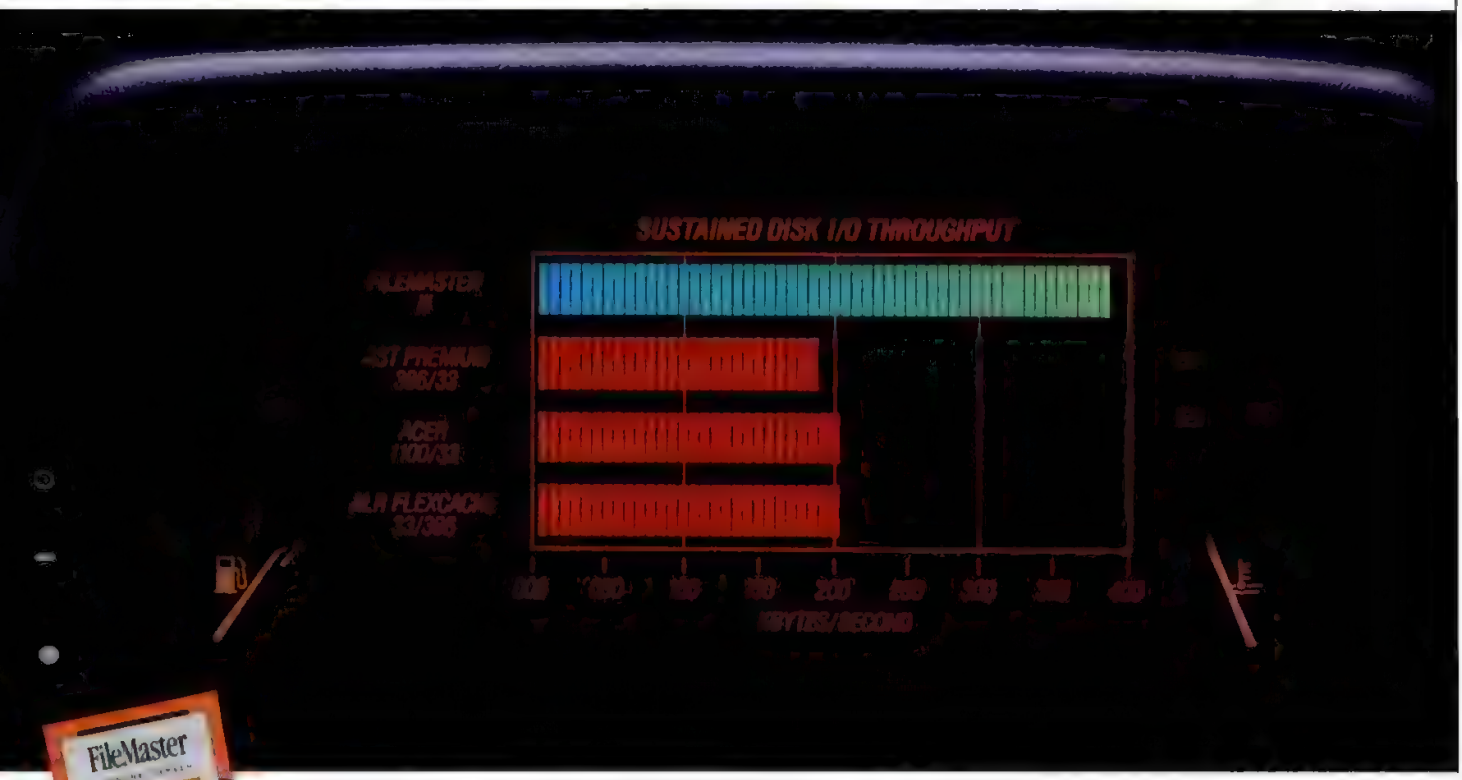

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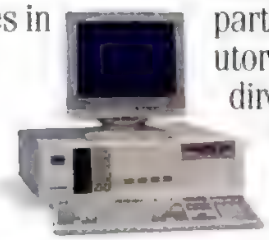

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The Super Servers

Compaq, Mitac, and NetFrame are leaders in multiprocessing LAN file servers. Are these systems PCs or minicomputers? When you look at their performance, categories don't seem so important.

PHOTO/ILLUSTRATION: BILL LONGCORE

BY JOHN DICKINSON

This story is about a brand new breed of computers, a breed that has emerged because the hunger for vast technological improvements in the business-place is so great. PC technology is quickly evolving from simply bringing us ever-more-powerful desktop systems to generating what will probably be the most important computers arriving on the market during the next decade.

THE LAN SURVIVAL GUIDE

The Intel family of microprocessors, the XT and AT (ISA) bus standards,

the newer MCA and EISA buses, and DOS itself have enabled users of virtually any hardware vendor's PC to operate any software vendor's PC program without difficulty. Most of the software in this PC technology chain has been upward compatible, which means that users can have ever more potent computers do the same work more effectively.

But a new impetus for growth in PC-based computing power comes from the increasing popularity of LANs and the emergence of server-based applications technology. Those twin developments have brought system demands that require LAN servers to perform in ways that simple boosts in PC processor power won't accommodate. Mainframes and minicomputers could provide the processing muscle, but it's far more attractive if PC-compatible processing technology is used at both server and workstation ends of the LAN. As a result, new approaches to providing standardized PC computing are emerging, and the computers that have entered the fray are as different as they are the same.

The common route taken by designers of the Compaq Systempro, the Mitac Series 500, and the NetFrame NF100—all examined here—is to build high-capability server technology by using multiple Intel processors surrounded by high-performance, largely standard parts. Each system is based on Intel's 80386 microprocessor, and two are designed to use Intel 80486 chips as well. Two of the three use I/O buses generally accepted as PC industry standards, and each is capable of running operating system software commonly accepted as standard throughout the computer industry.

Yet none of these machines resemble a standard PC except in vague ways. While they're designed to deliver standard PC computing power, they do so through new and more-powerful hardware mechanisms. Each is assembled differently from most PCs—and they are assembled differently from each other. They are also designed to use somewhat different software technology.

MULTIPLE PROCESSING

Multiple CPUs have been used in computers since the early 1960s. More often than not, such computers have used only two processors. While there are several ways to design computers that use multiple processors, these machines are always built to share RAM (random access memory) and to control common system resources like disk drives, communications facilities, and printers.

The earliest multiple-processor adaptations were planned around entirely separate computers—usually mainframe units—that were coupled together using their I/O buses. Built before the days of the multitasking CPU, these machines were designed to increase system throughput by allocating low-speed work—such as reading data from cards and printing reports—to low-speed computers. That meant that higher-speed (and more-expensive) computers could dedicate themselves to lots of computationally intensive jobs at the same time the low-speed chores were taking place.

Because of the size of corporate LANs, new performance pressure on LAN servers is clearly pushing us toward technologies that provide previously unheard-of service levels.

Designs using separate computers or processors that are far apart (electronically or physically) are called *loosely coupled*. Loosely coupled designs are still used in multiple-processor systems, but many newer schemes incorporate a *closely coupled* strategy. (The systems we review here fall into this category.) The processors in a closely coupled system generally communicate through the system's main RAM. Such a design is more difficult to build because it requires processors with enough intelligence to observe rules involving protected-memory areas, as well as memory interfaces that enforce those rules. The memory protection prevents one processor from corrupting data in memory being used by another processor in the system.

The differences between loosely coupled and closely coupled designs have more to do with operational speed than anything else. Clearly, the farther two processors are from each other, the longer it takes for data to travel between them and between commonly used resources. Sharing resources in this way is also electronically clumsy, because communication through I/O channels tends to be relatively slow. Thus, closely coupled designs are generally faster than loosely coupled ones.

TWO PROCESSING MODELS

What's more important than the connection technology is the role that each CPU plays in a multiple-processor system. There are two basic models: symmetric and asymmetric processing. *Symmetric processing* generally requires that each CPU has an equal share in the computer's operation, and that each has the opportunity to do the same job at about the same time and to provide the same performance level to the entire system. The *asymmetric processing* model assigns different roles to each processor in the system, providing each CPU with the opportunity to maximize its service contribution in a particular area. Both models are used by the systems covered here. As you can see in the diagram "Sharing System Memory," there are variations of and advantages to each scheme.

HOW SOFTWARE FITS IN

Asymmetric or symmetric processing can be implemented in hardware, software, or both. If the system itself is designed to be completely symmetric and to give all processors equal access to all components of the system, any sort of symmetric or asymmetric system can be implemented in software. If the designers have developed processors that are tied to particular components, then only asymmetric systems can be implemented in software.

While almost any operating system can be configured to take advantage of a high-performance multiprocessor system, such units are designed for multiuser network systems, not single-user applications. The size of LANs in corporate America is increasing rapidly, and, even before the first server-based application is implemented, more server processing power is being used every day to service more workstations. (That's especially true of the NetFrame design, where you can service more users on the same box by adding an I/O processor.) It's no surprise, then, that major LAN operating systems, including Novell's *Netware 386*, Microsoft's *LAN*

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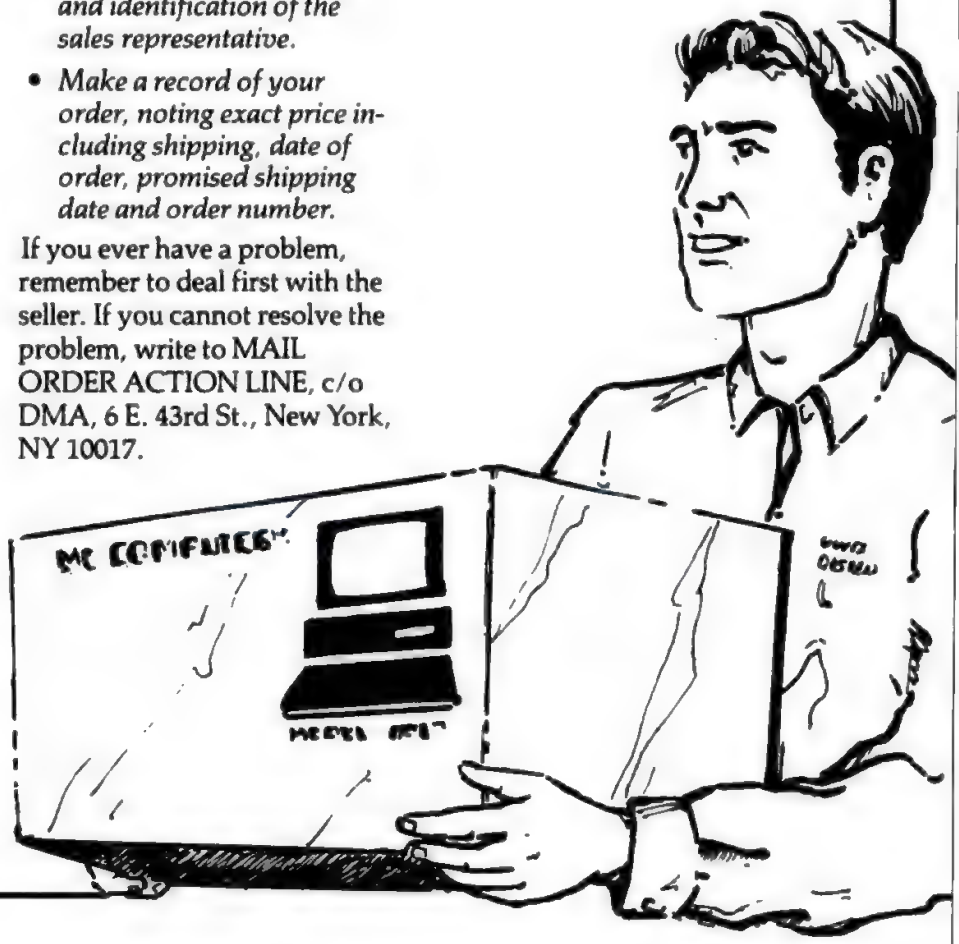

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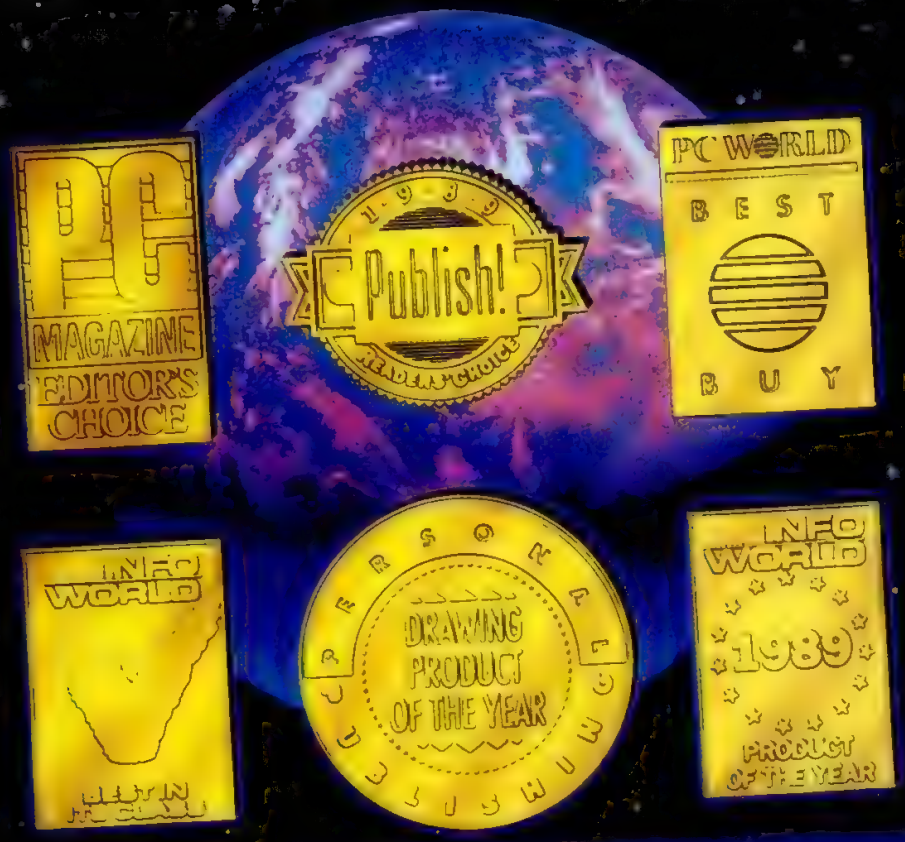

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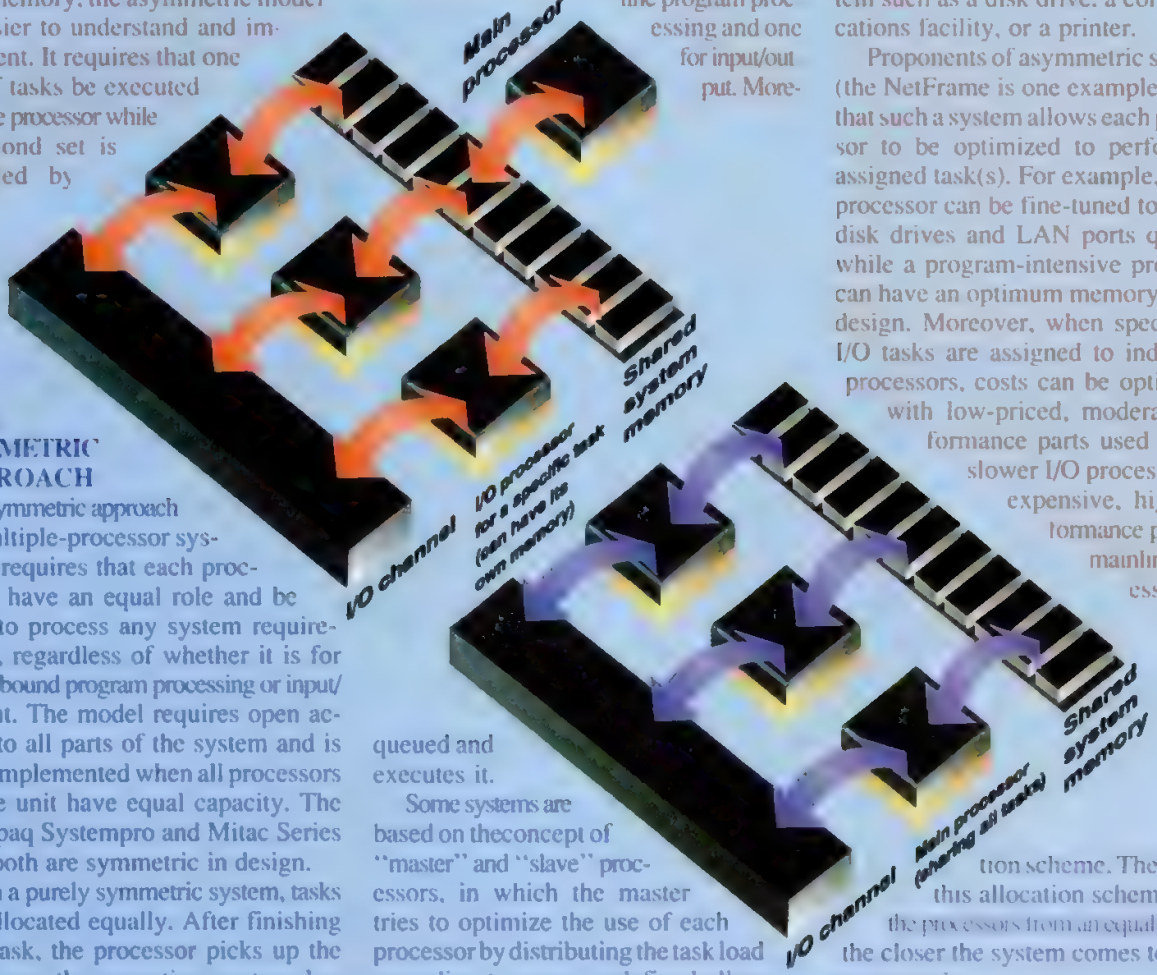
HOW PARALLEL PROCESSORS SHARE SYSTEM MEMORY

by John Dickinson

THE ASYMMETRIC APPROACH

Of the two approaches to shared system memory, the asymmetric model is easier to understand and implement. It requires that one set of tasks be executed by one processor while a second set is handled by another. The most common asymmetric design uses two processors: one for mainline program processing and one for input/output. More-elaborate designs use several I/O processors, one for each major I/O subsystem such as a disk drive, a communications facility, or a printer.

Proponents of asymmetric systems (the NetFrame is one example) argue that such a system allows each processor to be optimized to perform its assigned task(s). For example, an I/O processor can be fine-tuned to access disk drives and LAN ports quickly, while a program-intensive processor can have an optimum memory access design. Moreover, when specialized I/O tasks are assigned to individual processors, costs can be optimized, with low-priced, moderate-performance parts used for the slower I/O processes and expensive, high-performance parts for mainline processing.



THE SYMMETRIC APPROACH

The symmetric approach to multiple-processor systems requires that each processor have an equal role and be able to process any system requirement, regardless of whether it is for CPU-bound program processing or input/output. The model requires open access to all parts of the system and is best implemented when all processors in the unit have equal capacity. The Compaq Systempro and Mitac Series 500 both are symmetric in design.

In a purely symmetric system, tasks are allocated equally. After finishing one task, the processor picks up the next one the operating system has queued and executes it.

Some systems are based on theconcept of "master" and "slave" processors, in which the master tries to optimize the use of each processor by distributing the task load according to some predefined allocation scheme. The farther this allocation scheme takes the processors from an equal footing, the closer the system comes to being asymmetric. ■

Manager 2.0, and Banyan's *VINES*, are candidates for operating these computers (see "LAN Operating Systems: The Power Behind the Server" in this issue).

Of course, we can't overlook another player in the high-performance systems software sweepstakes: Unix. AT&T's ubiquitous time-sharing system has long been promoted as an important operating system for the PC's future. Its ability to handle multiprocessor environments may help it move closer to the limelight, especially when the Hewlett-Packard/SCO extensions that make a Unix host look like a *LAN Manager* file server become more widely available.

WHAT TO LOOK FOR

New performance pressure on LAN servers is clearly pushing us toward technologies that provide previously unheard-of service levels. Multiprocessor technology seems to be the route of choice—and the three machines reviewed here are the first steps into this new world.

But remember that this technology is new and different, and while many PC-industry standards are used in these designs, so far there is nothing resembling a multiprocessing standard. These vendors lead in establishing that standard, but since more multiprocessing design options are still under development, it's way too early to call a winner in this arena.

Meanwhile, server-based applications are barely available, and it won't be clear for a while yet what hardware/software combination will yield the best results. Besides, except for the NetFrame version of *NetWare 386*, production versions of operating system software are not yet available.

The LAN-versus-mini performance tests in this issue ("Can LANs Beat Minis?") will give you some insights into the speed of the three machines covered here, as will the benchmark test results reported in "LAN Operating Systems: The Power Behind the Server." You should

exercise caution when evaluating those numbers, however, because the state of the software makes their value uncertain. For example, when *Netware 386* runs on the Compaq Systempro, it takes advantage of only one processor, while on the NetFrame it uses two. Consistent results simply aren't available.

What is available is a rundown of each machine's interesting features, and information on how each one operates. Note that the Compaq Systempro and NetFrame computers we examined were final production units; the Mitac we saw was still in the prototype stage. The evaluations are worth your close attention, as they should provide plenty of food for thought when it comes time to make your next LAN server decision.

AMERICAN MITAC CORP.

Mitac Series 500

The $30,000-plus Mitac Series 500 looks like the odd progeny of a modern minicomputer mated with an art-deco-style table radio from the 1920s. Perhaps that's because it contains an odd combination of old and new technology, or this might reflect its joint U.S./Taiwanese engineering heritage.

The Series 500 system (which was delivered in prototype form to PC LAN Labs) owes much of its multiprocessor electronics design to Corollary Inc., a California-based company that provides engineering products to OEMs like American Mitac Corp. Corollary designed the basic, mostly symmetric multiprocessor architecture, and Mitac engineers adapted it to the computer.

FACT FILE

Mitac Series 500
American Mitac Corp., 410 E. Plumeria Dr., San Jose, CA 95134; (408) 432-1160.
List Price: With two 25-MHz 80386 processors, 8MB RAM, 380MB hard disk, 150MB tape drive, 1.2MB and 1.44MB floppy disk drives, $19,590; with four 25-MHz 80386 processors, two 80387-25 coprocessors, Hercules card, SCO Xenix, $30,434.
In Short: The prototype Mitac Series 500 looks more like a VAX than a tower PC. With the ability to hold up to five 25-MHz 486s, it has the potential to be the real speed demon. No doubt about it: the six cooling fans inside are necessary.

CIRCLE 417 ON READER SERVICE CARD

Like the Compaq Systempro, the Series 500 contains two buses, one (the "C-bus") for processor and shared memory communication and the other for I/O. Unlike the Compaq, the Series 500 has an I/O bus that was the older-style AT (ISA) architecture, rather than the newer, bus-mastering EISA design. The processors include at least two 25-MHz 80386s; the system can support a total of seven. A main 386 controls the system and basic I/O, including the SCSI disk drive. Additional processors are used for mainline processing as well as for controlling serial communications.

The base system board in the Series 500 contains, besides the main 386, a socket for an optional 80387 math coprocessor, a 64K static RAM cache operated by a custom write-back cache controller, and bus controllers for both the AT bus and the memory/processor bus. Also on the main board is the SCSI interface used for disk and tape drives, along with the keyboard and video controller for the main system console.

Each additional processor is mounted on a special board called the 386/SIO card. SIO stands for "serial input/output"; besides supporting mainline processing, the 386s on these boards maintain communication with anyone logged on to Unix using standard ASCII terminals attached to the Series 500. Each SIO port can support up to four 8-port terminal concentrators, which means that each 386/SIO card can support up to 32 users. At least one 386/SIO card must be installed in the Series 500. Such a card also includes a socket for an 80387, and the same customized write-back cache controller (operating a 64K static RAM cache) that is installed on the base system board.

DATA MAPPING AND CACHE COHERENCY

The Mitac supports 8MB to 64MB of RAM, housed on expansion cards of up to 16MB apiece. The memory design includes self-correcting logic for single-bit errors, but it is complicated both by the presence of the AT bus and by the write-back cache associated with each processor in the system. The AT design causes addressing to be complex, while the write-back cache presents a cache coherency problem, which is handled through the Mitac's intelligent C-bus.

The first 16MB of memory is called the AT-bus View. The first 1MB includes space for standard system ROM, which is used for BIOS, and memory space for I/O devices using the AT bus, which require the use of low memory addresses for buffer areas. The area from 1MB to 8MB can be used either for I/O devices or for the memory mapping described below. The I/O device area is visible only to the main system processor, which has exclusive access to the AT bus.

Memory addresses from 8MB to 16MB must be used for mapping data acquired through the AT bus into the high-memory space available to the rest of the system. Data acquired from the SCSI disk, for example, is placed in buffers located here by the main processor, and is acquired from here by other processors; from the mapping space, data can be moved to anywhere else in the 64MB address space.

Because we looked at a prototype unit, it's too early to guess what the Mitac Series 500's ultimate performance might be, although it's hard to imagine something powered by seven 386s being anything but fast.

The C-bus architecture is designed to maintain cache coherency in the presence of multiple processors using individual high-performance write-back caches. When only one processor is used in a system with a write-back cache, the cache controller is responsible for maintaining current data; whenever the processor writes to memory, the data goes into the cache, and the controller decides when it needs to unload the data back into main system memory. When a write-back cache is used in a multiprocessor system, it is possible for one processor to need data whose current value is in the cache memory of another processor; if the data is acquired from main memory, it may have an

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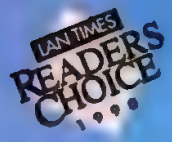

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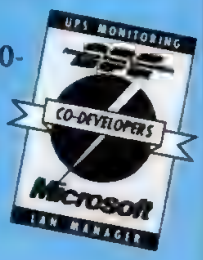

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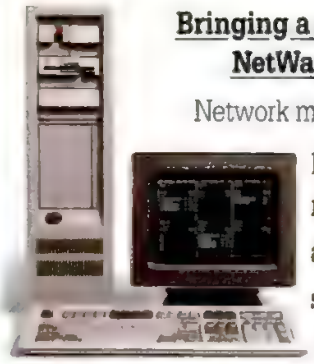
CIRCLE 281 ON READER SERVICE CARD



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old and erroneous value. (This problem does not occur when a write-through cache controller, such as the Intel 82385 found in the Compaq Systempro, is used in a multiprocessor system. That's because a write-through controller writes new values back to main memory so that it will always have the most current data.)

The Corollary-designed intelligent C-bus controller in the Mitac Series 500 recognizes when one processor requests data whose current value resides in another processor's cache. The cache controller that owns the current value prevents the data from being retrieved from main memory; instead, it places the correct value on the bus and sends that value to the requesting processor.

There are three slots for memory boards and six for processor boards on the C-bus. The design is a bit confusing at first because the AT-form-factor C-bus cards include what looks like an ISA connector. But this is used only for power and ground pickups, not for any signal interchange. There are one 8-bit and five 16-bit slots on the AT portion of the bus.

Unix is the operating system of choice for the Mitac Series 500. The initial version is SCO's Xenix System V, Release 2.3, with an enhanced, multiprocessor kernel. Mitac expects support soon from SCO's Unix System V, Release 3.2, the same version that runs on the Compaq Systempro. No plans have been announced for industry-standard LAN software to operate on the Mitac.

Because we looked at a prototype unit, it's too early to guess what the Series 500's ultimate performance might be, although it's hard to imagine something powered by seven 386s being anything but fast. Although that power lies in its favor, by designing a machine that's optimized for Unix, Mitac has cut itself off from current mainstream LAN operating systems and made the Series 500 less attractive to today's wider user community. But that doesn't mean you should completely take your eyes off Unix-based machines like this one. They could become far more attractive in the next year or so.

Like the Compaq Systempro, the Mitac Series 500 contains two buses, one for processor and shared memory communication, the other for I/O. The machine can hold two 25-MHz 80386 and five 80486 processors, 64MB RAM, and three 1GB hard disks and still have five expansion slots free. Since it features 64K of cache memory on each 386 CPU, a lack of speed should never be a problem.

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CPU	80286	80386SX	80386SX	80286	80386SX®
Speed	10 MHz	16 MHz	16 MHz	12 MHz	16 MHz
Wait State	0	0	0	1	0
Std Memory	1 MB	2 MB	1 MB	1 MB	2 MB
32-Bit Software Compatible	NO	YES	YES	NO	YES
On-Board Video	VGA	VGA	VGA	VGA	VGA
Monitor	OPTION	OPTION	OPTION	OPTION	OPTION
Fixed Disk	30 MB	30 MB	OPTION	OPTION	OPTION
Floppy Disk	1.44 MB	1.44 MB	1.44 MB	1.44 MB	1.44 MB
Price	$2895	$3895	$1895	$2699	$3299

Note: Information on this chart is based on published materials.

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CIRCLE 227 ON READER SERVICE CARD

COMPAQ COMPUTER CORP.

Compaq Systempro

The Compaq Systempro is the most ordinary-looking of the multiprocessor network servers covered here. Its highly stylized tower design covers a strong but lightweight aluminum chassis and reflects Compaq's recent plunge into good-looking computers. The Systempro is also the closest in operation to a standard PC—you can even boot DOS on it—but it has more to offer you and your LAN environment than an ordinary PC. Much more.

The Systempro is designed for speed from top to bottom and is configured to offer its best performance in a LAN or multiuser environment. The base-configuration Model 240 ($15,999) comes equipped with a 33-MHz 80386 processor and uses the Intel 82385 controller to manage a 64K cache of 25-nanosecond static RAM. The cache is interfaced to 4MB of main memory through the use of Compaq's now-legendary Flexible System Architecture (Flex). Input and output are carried out across an EISA bus, and standard disk equipment includes Compaq's new IDA (Intelligent Drive Array) disk controller operating a two-spindle 240MB disk drive array pair. The system also includes a 1.2MB floppy disk drive.

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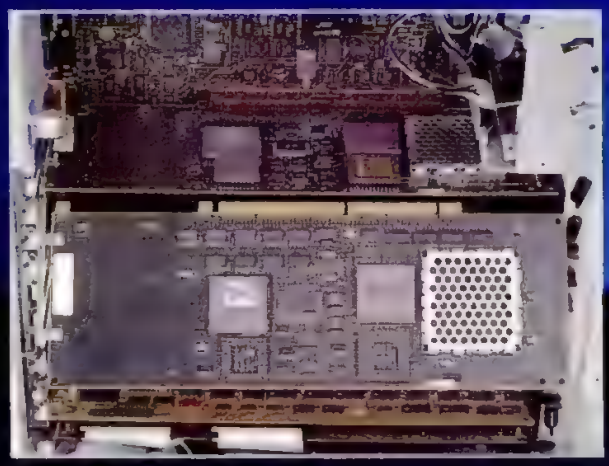
A fully loaded $42,156 Compaq Systempro comes complete with two 33-MHz 80386 processors located on cards attached to the passive backplane system board, an 840MB hard disk, a tape drive, a VGA monitor, two math coprocessors, and a modem. Flex architecture lets the processors communicate through protected areas of shared memory and allows for fully symmetric processing. To insure data integrity, the Systempro showcases disk guarding and disk mirroring, which provide protection against equipment failure. With five expansion slots to spare and the option of installing two 33-MHz 80486 processors, it's on the forefront of server technology.



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CIRCLE 292 ON READER SERVICE CARD

tempro allows for fully symmetric operation of the two processors.

Unlike previous Compaq PCs, the unit has a system board that employs a passive backplane design, which places the main and second processor on a board mounted in a specially designed slot. (The processor board also has room for both the Weitek 3167 and Intel 80387 math coprocessors.) Four such slots exist in the Systempro: two are designed specifically for memory expansion, one must contain a processor board, and the fourth can accept either a memory or a processor board.

System memory can be expanded from 4MB to 256MB, and can consist of 1-megabit or 4-megabit DRAMs mounted on proprietary 2MB, 4MB, 8MB, and 32MB memory cards. The cards are installed in sockets mounted on the proprietary system-memory boards. The largest, a 6-socket memory board, can hold 96MB of 32-bit DRAMs. That means that a *dual-processor* Systempro is limited to 192MB, rather than the advertised 256MB; however, that's probably enough to take care of you until Compaq designs a denser memory board.

THE STORY OF EISA AND IDA

Compaq was the ringleader of the "Gang of Nine" that specified the EISA I/O bus, so it's no surprise that the Systempro is an EISA machine. Seven EISA expansion slots give the computer high-speed access to LAN-fed data via the new 32-bit network interface cards from Novell, Proteon, and others (see "Beating I/O Bottlenecks with 32-bit LAN Adapters"). They also provide the network server access to virtually any 8-, 16-, or 32-bit peripheral technology that's of interest to clients on the system.

Perhaps best of all, the new EISA bus inspired Compaq to build the innovative IDA controller, which provides a flexible method of managing disk drives in a networked environment. You might want to consider the Intel 80186-based controller as an asymmetric addition to the Systempro's multiprocessing capabilities because, much like a mainframe's disk controller, it adds serious amounts of processing intelligence to the disk-based data management process. (Of course, it's not a true asymmetric addition, as the main processors have to operate the device drivers that tell the IDA what to do.)

Compaq's engineers took a serious look at how disk performance could be optimized in a LAN or multiuser environment before they put mouse to CAD program. Perhaps their most important conclusion is that not every application needs the same sort of disk management: users have different priorities when it comes to the inevitable tradeoffs among data acquisition speed, data volume, and data security. The Compaq IDA is designed to fulfill the most common of those needs.

The IDA makes life as simple as possible for the operating system controlling the Systempro because whatever else is going on, all drives operated by the IDA can be treated as a single disk. The IDA also has designed-in bus-mastering technology; it can transfer data across the bus without any supervision from the CPU.

Even though the system thinks there is but one disk drive, the smallest number of disks controlled by the IDA is one array pair—that is, two Conner-made 3.5-inch half-height hard disks. Array pairs come in 240MB and 420MB capacities, with each drive in the pair having half that capacity. Disk drives are added in array pairs, and the Systempro cabinet can hold up to four pairs (eight physical drives). If 420MB array pairs are used, that yields a capacity of 1.6 gigabytes; you get just short of 1GB if the 240MB pairs are installed. An expansion cabinet that will hold up to eight more drives is planned.

Adding capacity by adding disk drives is nothing new, but the IDA adds drives in such a way that the Systempro can acquire or store data more quickly. All disks are controlled so that the same sectors are indexed to all the drive heads at the same time. This allows the IDA to treat them in parallel form, accessing data from (or to) all disks at the same time. If you have four disk drives installed (that's two array pairs), four sectors of data written to the drive array will be stored on the four physical drives, one sector per drive. Therefore, the arithmatic is simple: the time required to write or read data is divided by the number of drives installed.

The IDA provides optimum service to simultaneous multiple disk access requests. Requests for data to be read or written from different drives in the array can be serviced at the same time. At 16 MHz, the 80186 processor is fast enough at optimizing the processing of queued requests that the quickest possible data transfers to and from memory take place.

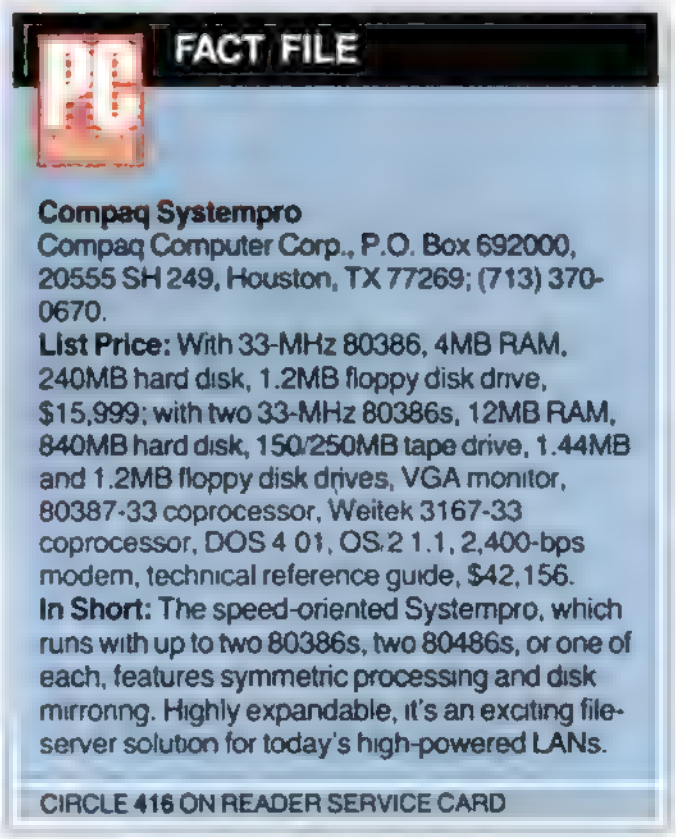
DISK MIRRORING

Reliability is a major issue for some installations, and the IDA offers two methods of providing serious data integrity protection to Systempro users. Disk mirroring has long been used by fault-tolerant minicomputers, and it can be implemented in the IDA: any data stored is written to two disks in the system at the same time.

While disk mirroring provides almost perfect protection against equipment failure, it cuts storage capacity in half, so Compaq developed a technology called *disk guarding*, which encodes all data written to three disk drives onto a fourth one. In the event of a base disk's failure, data can be reconstructed from the encoded data and the data from the other disks. If the encoded disk fails, it can be replaced and the encoded data rebuilt from the other three. The advantage of disk guarding is that total disk capacity is reduced by only 25 percent.

Compaq plans to make its own version of *LAN Manager* the principal Systempro operating system when Version 2 becomes available from Microsoft. *LAN Manager* will operate the two processors asymmetrically. One processor will operate the *LAN Manager* kernel and any server-based applications, while the other will operate the full, 32-bit version of the Microsoft High Performance File System.

Currently, SCO Unix is available for the Systempro. The SCO implementation of the AT&T time-sharing system operates the processors symmetrically using the Multiprocessing Extension to the company's System V/386 Release 3.2, which was developed jointly with Compaq and Corollary Inc. The implementation uses a shared copy of Unix, which allocates tasks


FACT FILE

Compaq Systempro
Compaq Computer Corp., P.O. Box 692000, 20555 SH 249, Houston, TX 77269; (713) 370-0670.
List Price: With 33-MHz 80386, 4MB RAM, 240MB hard disk, 1.2MB floppy disk drive, $15,999; with two 33-MHz 80386s, 12MB RAM, 840MB hard disk, 150/250MB tape drive, 1.44MB and 1.2MB floppy disk drives, VGA monitor, 80387-33 coprocessor, Weitek 3167-33 coprocessor, DOS 4.01, OS/2 1.1, 2,400-bps modem, technical reference guide, $42,156.
In Short: The speed-oriented Systempro, which runs with up to two 80386s, two 80486s, or one of each, features symmetric processing and disk mirroring. Highly expandable, it's an exciting file-server solution for today's high-powered LANs.

CIRCLE 416 ON READER SERVICE CARD

MULTIPLE-PROCESSOR SERVERS: SUMMARY OF FEATURES

Products listed in ascending price order

	Compaq Systempro	Mitac Series 500	NetFrame NF100
List price	$15,999	$19,590	$22,500
Microprocessor options	Up to two 33-MHz 80386s or two 33-MHz 80486s	Two to seven 25-MHz 80386s, or two 25-MHz 80386s and up to five 25-MHz 80486s	Up to five 25-MHz 80386s and one 8088
Motherboard manufacturer	Compaq	Mitac	NetFrame
Chip set manufacturer	Compaq, Intel	GLUE Logic	Intel, NetFrame
System RAM arrangement	Page mode	Nibble mode	Page mode
Wait states	0	0	0
Coprocessor	80387-33 and Weitek 3167-33	80387-25 or 80487-25	80387-25
PROCESSOR RAM CACHE			
Cache controller	Two	One per CPU	One
RAM cache size	64K per processor	64K on 386 processor, 256K on 486	32K per processor
Rated speed (nanoseconds)	25	25	25
ADD-IN MEMORY BOARD			
Installed RAM	12MB	8MB	8MB
Maximum installable RAM	256MB with one processor, 192MB with two processors	64MB	64MB with one processor, 192MB with five processors
Chip size	1MB or 4MB	1MB	1MB
Password in ROM	■	■	❑
System shadowing/can be disabled	■ / ❑	■ / ■	❑ / ❑
Video shadowing/can be disabled	■ / ❑	■ / ■	❑ / ❑
HARD DISK			
Manufacturer	Conner Peripherals	Maxtor	CDC, Hewlett-Packard, Hitachi, Maxtor
Disk capacity	840MB	380MB	760MB
Number installable	2	3	4 (21 with expansion cabinet)
Interface	Intelligent Drive Array	SCSI	SCSI
Average access time (milliseconds)	18	18	16
Disk mirroring	■	❑	■
Controller location	Card	SCSI/CPU board	Card
Controller manufacturer	Compaq	Corollary/Mitac	NetFrame
Hard disk options	120MB, 210MB, 320MB, 650MB	100MB, 200MB, 380MB, 760MB, 1GB	380MB, 760MB
TAPE DRIVE			
Capacity	150MB	150MB	Unlimited
Tape medium	DC-600	DC-600	8mm tape or DAT
EXPANSION			
Expansion slots	7 EISA, 4 proprietary	6 C-bus, 3 C/AT-bus, 5 AT-bus, 1 I/O	3 I/O or application processor, 2 memory expansion
Available slots	4 EISA, 1 proprietary	3 C-bus, 3 C/AT-bus, 4 AT-bus	2 I/O or application processor, 2 memory expansion
Drive bays	10 half-height, 1 one-third-height	6 half-height, 1 one-third-height	4 full-height, 16 half-height
PHYSICAL FEATURES			
Power supply (watts)	300	500	1,500
Switchable power supply	■	■	■
Number of device connectors	11	7	None
Keyboard lock	■	❑	❑
Case lock	■	❑	❑
Power-on switch	Front	Front (key required)	Remote-controlled
MISCELLANEOUS			
Distribution channel	Dealer	Reseller	Reseller
Warranty	1 year	1 year	1 year
Service	Return to dealer	Ship to manufacturer	On-site
FCC certification class	B	B (pending)	B

■—Yes ❑—No

from the run list to each processor equally on a FIFO (first in, first out) basis.

Banyan has announced that its Unix-based *VINES* network operating system will also be available for the Systempro; *VINES* will use the processors symmetrically. Novell has not introduced a version of *NetWare 386* for the Systempro but plans to do so shortly. It will probably implement the multiple processors asymmetrically.

It's hard to argue with either the Compaq name or the quality and design of the Systempro. Performance of even a one-processor model tends to be blistering, and the unit would be worth buying just for the flexibility, security, and performance offered by the new IDA drive technology. The early-morning line is that the Systempro may be the multiprocessor of choice, although you may want to keep an eye on other things as well. Two 486s are probably enough for any server needs you have in the next year, but you should look ahead and determine whether your server-based applications will take you beyond that capacity. You can be sure that Compaq is looking at that issue, too. (For more on the Systempro and its performance, see "The Best Computer $43,000 Can Buy," *PC Magazine*, April 10, 1990.)

NETFRAME SYSTEMS INC.

NetFrame NF100

NetFrame Systems' sleek, matte-black-finished file servers look so much like hi-tech stereo speakers you'll be more likely to ask what size woofers they have than how much CPU power they contain. In fact, the NetFrame NF100, NF300, and NF400 computers host substantial 386 or 486 processing power. Their multiprocessing design and overall system architecture inherits a lot of technology from the mainframe world. The combination of networks and mainframes gives NetFrames their name.

The networking side of the NetFrame strategy is at the root of the system architecture. It is an asymmetric multiprocessor design that has two dimensions along which LAN-based processing power can grow. On one dimension, more users can be added by increasing input/output processing; on the other, processing power can be added to operate one or more server-based applications.

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Borland International ... NCP
4330 ⊞Turbo C Professional Pack 1.0 . . . . 175.
4332 ⊞Turbo Pascal Professional Pack 1.0. 175.
6242 ▣Quattro Pro 1.0 . . . . . 289.
1514 ▣Paradox 3.0. . . . . 469.
Brightbill-Roberts ... NCP
5408 □Hyperpad 1.0 . . . . . 85.
Broderbund ... CP
1434 □New Print Shop *(NCP)* . . . . . 39.
1433 ▣Memory Mate 3.01 *(NCP)* . . . . . 45.
ButtonWare ... NCP
6419 ▣PC-File 5.0. . . . . 75.
Caere ... NCP
6004 ▣Omnipage 386 2.1 . . . . . 599.
Central Point ... NCP
5039 ▣PC Tools Deluxe 6.0. . . . . 89.
5038 □Copy II PC 5.0. . . . . 27.

Chipsoft ... NCP
1663 ⊞TurboTax for 1989 Taxes 7.0 . . . . $45.
⊞Individual States. . . . . .each 34.
Chronos Software ... NCP
4387 ▣Who•What•When 1.09 . . . . . 119.
Concentric Data Systems ... NCP
6575 ▣R & R Relational Report Writer 3B 109.
Corel Systems ... NCP
5506 □Corel Draw 1.1. . . . . 329.
Crosstalk Communications ... NCP
2908 □Crosstalk XVI 3.7 . . . . . 119.
5611 □Crosstalk for Windows 1.0 . . . . . 129.
DacEasy ... NCP
1748 ▣DacEasy Accounting 4.0 . . . . . 89.
Data Storm ... NCP
4798 ▣PROCOMM PLUS 1.1 . . . . . 52.
Delrina Technology ... NCP
4325 ▣PerFORM 2.0. . . . . 169.
Delta Technology ... NCP
5829 ▣Direct Access 5.0. . . . . 52.
Digital Composition Systems ... NCP
5876 ▣db Publisher Report Maker 2.0 . 185.
Dow Jones ... NCP
5494 ⊞News/Retrieval Membership Pkg. 24.
5th Generation ... NCP
2762 □Mace Utilities 1990. . . . . 89.
3950 ▣Fastback Plus 2.1 . . . . . 109.
FormWorx ... NCP
5810 □FormWorx with Fill & File 2.5 . . . . 85.
Fox Software ... NCP
6188 ⊞FoxPro 1.0. . . . . 489.
2233 ⊞Foxbase Plus 2.1 . . . . . 199.
Funk Software ... NCP
2228 □Sideways 3.21 . . . . . 42.
4479 □Allways 1.0 . . . . . 85.
Generic Software ... NCP
2265 ⊞Generic CADD Level 3 1.1.3 . . . 169.
Great American Software ... NCP
4880 □One Write Plus Accounting Sys. 2.06 179.
5825 ▣Money Matters 1.0. . . . . 55.
Harvard Associates ... NCP
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Hayes ... NCP
2293 ▣Smartcom II 3.0. . . . . 89.

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6599 □Current 1.0 ..... 239.
Individual Software ... NCP
2408 □Professor DOS 4A ..... 27.
6222 □Resume Maker 1.0 ..... 29.
Intuit ... NCP
2426 ▣Quicken 3.0 ..... 39.
Lord Publishing ... NCP
5191 ▣Ronstadt's Financials 1.02 ..... 75.
Lotus ... NCP
5417 □1-2-3 3.0 ..... call
5653 □1-2-3 2.2 ..... call
5134 ▣Magellan 1.0 ..... 149.
4131 ▣Agenda 1.0 ..... 275.
2660 □Freelance Plus 3.01 ..... 345.
MECA ... NCP
4603 ▣Andrew Tobias' Tax Cut 1989 ..... 45.
2798 □Managing Your Money 6.0 ..... 119.
Microcom ... NCP
6234 □CarbonCopy Plus 5.2 *(2 req.)* ... 115.
Micrografx ... NCP
6294 ▣Draw Plus 1.0 ..... 289.
Micro Logic ... NCP
2968 □Tornado 1.8 ..... 55.
6787 ▣Info Select 1.0 ..... 55.
Microlytics ... NCP
2731 □GOfer 2.0 ..... 45.
Microsoft ... NCP
2860 □Learning DOS 2.0 ..... 35.
2899 □Windows 286 2.1 ..... 69.
2904 □Works 2.0 ..... 99.
2901 □Word 5.0 ..... 209.
6195 ▣Word for Windows ..... 329.
2856 ▣Excel 2.1 *(req. 80286/80386)* ... call
6133 ▣Excel for OS/2 1.0 ..... 339.
5188 □QuickPascal 1.0 ..... 55.
2894 □QuickBASIC 4.5 ..... 69.
2895 □QuickC 2.0 ..... 69.
2853 ▣C Compiler 6.0 ..... 339.
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4925 □PC-Kwik Power Pak 1.5 ..... 79.

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▣*Microsoft C 6.0*–Set a new performance record with faster, more reliable code. New features include more sophisticated code optimization, powerful debugging enhancements, and second generation OS/2 support ..... $339.

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Norton-Lambert ... NCP
4928 □Close-Up Customer 3.0 ..... 135.
4929 □Close-Up Support 3.0 ..... 165.
Paperback Software ... NCP
6358 □VP-Planner 3D 1.0 ..... 155.
PC Globe ... NCP
5902 □PC Globe 3.0 ..... 39.
5900 □PC USA 1.0 ..... 39.
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3126 ▣SeeMORE 2.0 ..... 59.
4328 ▣Look & Link 1.1 ..... 59.
4384 ▣Ultravision 2.0 ..... 79.
Peter Norton ... NCP
3152 ▣Norton Commander 3.0 ..... 89.
3146 ▣Advanced Utilities 4.5 ..... 89.
6397 ▣The Norton Backup 1.0 ..... 89.
Precision Software ... NCP
6600 ▣Superbase 4 for Windows ..... 459.
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6422 □QRAM 1.0 ..... 49.

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3221 □Expanded Memory Mgr. 386 5.0 . 59.
3220 □DESQView 2.26 ..... 79.
4586 □DESQView 386 1.1 ..... 129.
6400 □Manifest 1.0 ..... 39.
Reality Technologies ... NCP
6572 ▣WealthBuilder 1.1 ..... 145.
Reference Software ... NCP
4396 ▣Grammatik IV 1.0 ..... 52.
Revolution Software ... NCP
4480 ▣VGA Dimmer 2.01 *(screen saver)* . 19.
RightSoft ... NCP
4155 ▣RightWriter 3.1 ..... 54.
Samna ... NCP
5799 ▣Ami Professional 1.0 ..... 309.

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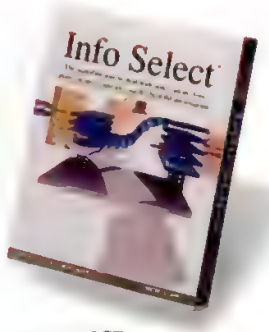

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3478 □PFS:First Choice 3.02 ..... 105.
3496 ▣Professional Write 2.12 ..... 149.
3493 ▣Professional File 2.01 ..... 199.
3482 □Harvard Graphics 2.13 ..... 339.
6289 ▣Draw Partner 1.0 *(for Harvard Graph.)* 59.
Symantec ... NCP
5383 ▣Budget Express 1.0 ..... 105.
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3425 □Q&A 3.0 ..... 229.
3431 □Timeline 4.0 ..... 469.
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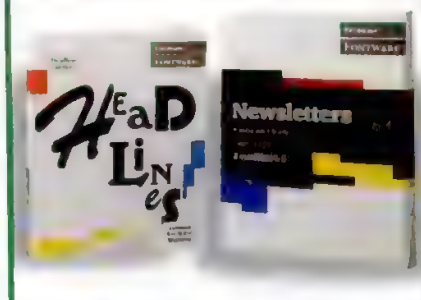
Timeworks ... NCP
6253 ▣Publish-It! 1.1 ..... 115.



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5179 ▣LapLink III 3.0 ..... 95.

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Vericomp ... NCP
3765 ▣SoftBytes 2.0 ..... 35.
6771 ▣Memory Master 1.0 ..... 45.

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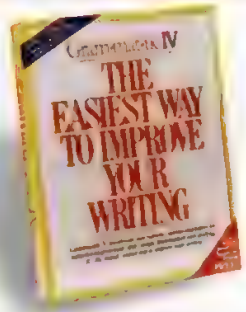
3804 ☐WordPerfect 5.1 ..... 265.
6685 ▣DrawPerfect 1.0 ..... 279.

WordStar USA ... NCP
2825 ☐WordStar Prof. 6.0 ..... 249.
5000 ☐*Upgrade to Version 6.0* ..... 89.

Xerox ... NCP
3812 ☐Ventura Publisher 2.0 ..... 529.



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▣*Grammatik IV 1.0*—Checks for grammar, style, usage, punctuation and spelling errors in one pass! Now works within WordPerfect 5.1, Microsoft Word 5.0, Professional Write 2.1, WordStar 5.5, XY Write III & more.... $52.

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XYQUEST ... NCP
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5701 ☐Where/Time Carmen Sandiego? ... 32.
6295 ▣The Playroom ..... 32.
5851 ▣SimCity ..... 33.

Electronic Arts ... NCP
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4659 ▣Chessmaster 2100 *(CP)* ..... 35.
5804 ▣Deluxe Paint II *(Enhanced)* ..... 89.

Microprose ... CP
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5823 ☐Red Storm Rising ..... 39.

Microsoft ... NCP
2858 ☐Flight Simulator 4.0 ..... 39.

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6796 ▣Codename: Iceman ..... 39.
5106 ▣Space Quest III ..... 39.

Spectrum Holobyte ... NCP
5993 ▣Welltris ..... 22.

Stone & Assoc. ... NCP
3435 ▣My Letters, Numbers, Words *(2 to 6)* 22.
3438 ▣1st Math *(ages 5 to 8)* ..... 22.
3439 ☐2nd Math *(ages 7 to 16)* ..... 27.

Sublogic ... NCP
6190 ☐Air Transport Pilot ..... 33.

True BASIC, Inc. ... NCP
▣Kemeny/Kurtz Math Series:
10 titles ..... *each* 45.

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Manufacturer's standard limited warranty period for items shown is listed after each company name. Some products in their line may have different warranty periods.

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6811 360SX *(stand-by power source)*... 255.

AST Research ... 2 years
1299 SixPakPlus 384k C/S/P ..... 187.
6795 SixPak 286 512k ..... 209.
4107 RAMpage Plus 286 512k ..... 419.
4105 RAMpage Plus Micro Channel 512k 419.

Brother International ... 1 year
5787 HL-8e Laser Printer ..... 1799.
5788 HL-8Ps PostScript Laser Printer . 2949.

Compucable ... 2 years
1604 2-Position switch box ..... 25.

Cuesta ... 1 year
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Curtis ... lifetime
1694 Emerald SP-2 ..... 36.
1707 Ruby SPF-2 *(6 outlets)* ..... 55.
1708 Ruby-Plus SPF-2 Plus ..... 65.

Diconix ... 1 year
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Epson ... 1 year
We are an authorized Epson Service Center.
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1904 FX-1050 *(136 col., 264 cps, 9 pin)*.. call
5183 LQ-510 *(80 col., 180 cps, 24 pin)*... call
1930 LQ-850 *(80 col., 264 cps, 24 pin)* .. call
6765 LQ-1010 *(136 col., 180 cps, 24 pin)* call
1917 LQ-1050 *(136 col., 264 cps, 24 pin)* call
4116 LQ-2550 *(136 col., 333 cps, 24 pin)* call
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1052 Printer-to-IBM cable *(6 feet)* ..... 15.

5th Generation ... 1 year
3952 Logical Connection 512k ..... call

Hayes ... 2 years
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2308 Smartmodem 2400B *(w/Smartcom II)* 279.
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2318 Graphics Card Plus ..... 189.

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6582 Laserjet IIP *(w/toner)* ..... 1039.
6581 Deskjet Plus *(w/ink cartridge)* .... 719.

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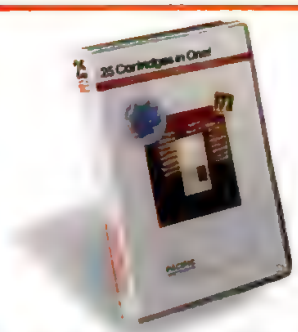

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5119 2400 Baud External Modem..... 179.
6420 2400EX MNP Modem..... 229.
2346 Inboard 386/PC w/1 Meg *(w/free Ami)* 579.
4266 Above Board Plus 512k..... 419.
4267 Above Board Plus I/O 512k..... 449.
5336 Above Board Plus 8 2 Meg..... 599.
5342 Above Board Plus 8 I/O 2 Meg ... 629.
4272 Above Board 2 Plus 512k..... 469.
5396 Above Board MC 32 0k ..... 359.
4275 Connection CoProcessor *(w/Fax-it)*. 529.
4857 Visual Edge ..... 449.
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2370 80287-8 *(for 8 MHz 80286 CPU's)* . 199.
2369 80287-10 *(for PS/2 Models 50 & 60)* 229.
4750 80387SX *(for 80386SX CPU's)*.... 309.
2371 80387 *(for 16 MHz 80386 CPU's)*.. 349.
2372 80387-20 *(for 20 MHz 80386 CPU's)*399.
Kensington Microware ... 1 year
2587 Master Piece Plus Remote ..... 89.
2582 Master Piece Plus..... 109.
5697 Expert Mouse *(Trackball for PS/2)* . 115.
Key tronic ... 3 years
4518 101 Plus Keyboard..... 99.
Kraft ... 5 years
5801 New Game Adapter *(2 game ports)*. 27.
5800 3 button Thunder Joystick..... 29.
5802 Trackball..... 69.
Logitech ... limited lifetime
5464 Series 2 Mouse *(C9 for PS/2's)* .... 69.
5151 HiREZ Mouse *(C9)* ..... 85.
6029 Trackman *(Trackball) serial* 85. *bus* 89.
4297 ScanMan Plus *(hand scanner)* ... 185.
6786 ScanMan w/Catchword 1.0..... 315.
Micron Technology ... 2 years
6005 Ascend 4 Meg Brd. for Compaq 386 699.
6669 Intensify 2 Meg Expansion for HP LaserJet II *(upgradeable to 4 Meg)*. 329.
6013 Beyond Mem. Brd. for Model 50 *(512k)* 359.
Microsoft ... lifetime
2897 Mouse with Paintbrush ..... 109.
2898 Mouse with Windows 286 2.1 .... 139.

MicroSpeed ... 1 year
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6010 FastTRAP 3D Trackball *serial* 99. *bus* 109.
Mouse Systems ... lifetime
5845 White Mouse *(bus or serial)*..... 69.
5997 Trackball *(1 yr. wrnty.) serial* 75. *bus* 85.
4306 PC Mouse II w/PC Paint+ ..... 89.
NEC ... 2 years
4799 Multisync 2A *(VGA Monitor)* ..... 499.
5085 Multisync 3D Monitor ..... 689.
6208 Multisync 4D Monitor..... 1199.
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3103 2400 Baud Internal Modem ..... 135.
3102 2400 Baud External Modem..... 179.
5286 2400 Baud Int. MNP Modem *(Lev. 5)* 175.
5285 2400 Baud Ext. MNP Modem *(Lev. 5)* 209.
4542 2400 Baud Internal Modem for PS/2. 229.
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4561 Safe 250W *(standby power bkup)* 199.
4562 Safe 425W *(standby power bkup)* 329.
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5402 SOTA 386i-16 *(16 MHz accelerator)* 389.
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5140 TheComplete Page Scanner..... 549.
4887 TheComplete Fax 9600 ..... 429.
5828 TheComplete Communicator ..... 559.
6797 TheComplete Portable Scanner.... 319.
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4958 T1600 Laptop *(12 MHz, 20 Meg)* . 3249.
Tripp Lite ... 2 years
6199 Isobar 4-6 *(4 outlets, 6 ft. cord)* .... 49.
6200 Isobar 6-6 *(6 outlets, 6 ft. cord)* .... 59.
6019 LS 600 Line Stabilizer..... 85.
Video 7 ... 7 years
5883 1024i VGA *(includes 512k)* ..... 289.
4931 VRAM VGA 512k ..... 449.

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6248 AT Floppy/Hard Drive Controller .. 129.

Toshiba ... 1 year
T1000SE—Powerful yet extremely portable laptop computer. 80C86 processor, 1Mb RAM, 1.44 Mb floppy drive, 82-key keyboard, and backlit supertwist display. Weighs less than 6 pounds!..... call

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5113	44 Meg Cartridge Tripak *(5¼")*	249.
2499	PC2 Card *(controller required)*	169.

Mountain Computer ... 1 year

2917	40-60 Meg Internal Tape Drive	379.
5502	83-152M Ext. Tape Drive	759.
5500	83-152M Int. Tape Drive	629.
6153	DC2120 Cartridge *(5 pack)*	135.
5190	DC2000 Pre-formatted Cartridges ea.	35.

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5010	1.2 Meg External *(for PS/2's)*	215.
6602	1.44 External *(for PC/XT/AT)*	239.

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3105	Hardcard 20 Meg *(49 ms)*	519.
3106	Hardcard 40 Meg *(28 ms)*	599.
6425	Hardcard II 40 Meg *(19 ms)*	599.
6424	Hardcard II 80 Meg *(19 ms)*	699.

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4951	720k Drive *(specify XT or AT, 3½")*	79.
4670	1.44 Meg Drive for XT *(3½")*	99.
4326	1.44 Meg Drive for AT *(includes Bastech software utilities, 3½" copy prot.)*	119.

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6360	CheckFree Xpress	25.

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1676	CompuServe Information Service	24.

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The newest modems from Intel provide MNP/Level 5 support for faster, more reliable communications. Also operates in Hayes-compatible mode for standard communication tasks.
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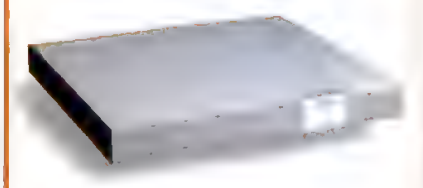

Kensington Microware ... 1 year

Master Piece Plus—An elegant power control center with complete surge protection and noise filtering. Includes five outlets, unique low voltage indicator, modem protection, anti-static pad, and swivel base ..... **$109.**

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3292	5¼" DS/HD 1.2Mb Disks *(Qty. 10)*	19.
3297	3½" DS/DD 720k Diskettes *(Qty. 10)*	14.
3298	3½" DS/HD 1.44Mb Diskettes *(Qty. 10)*	29.
6659	QD 2000 Tape Cartridge	19.
6712	QD 600A Tape Cartridge	27.
6715	QD 6150 Tape Cartridge	27.

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6556	256k DRAMs *(100 nanosecond)*	call
3248	256k DRAMs *(120 nanosecond)*	call
4366	1 Meg x 9 SIMMs *(100 nanosecond)*	call
5510	1 Meg x 9 SIMMs *(80 nanosecond)*	call
5746	1 Meg Chips *(80 nanosecond)*	call

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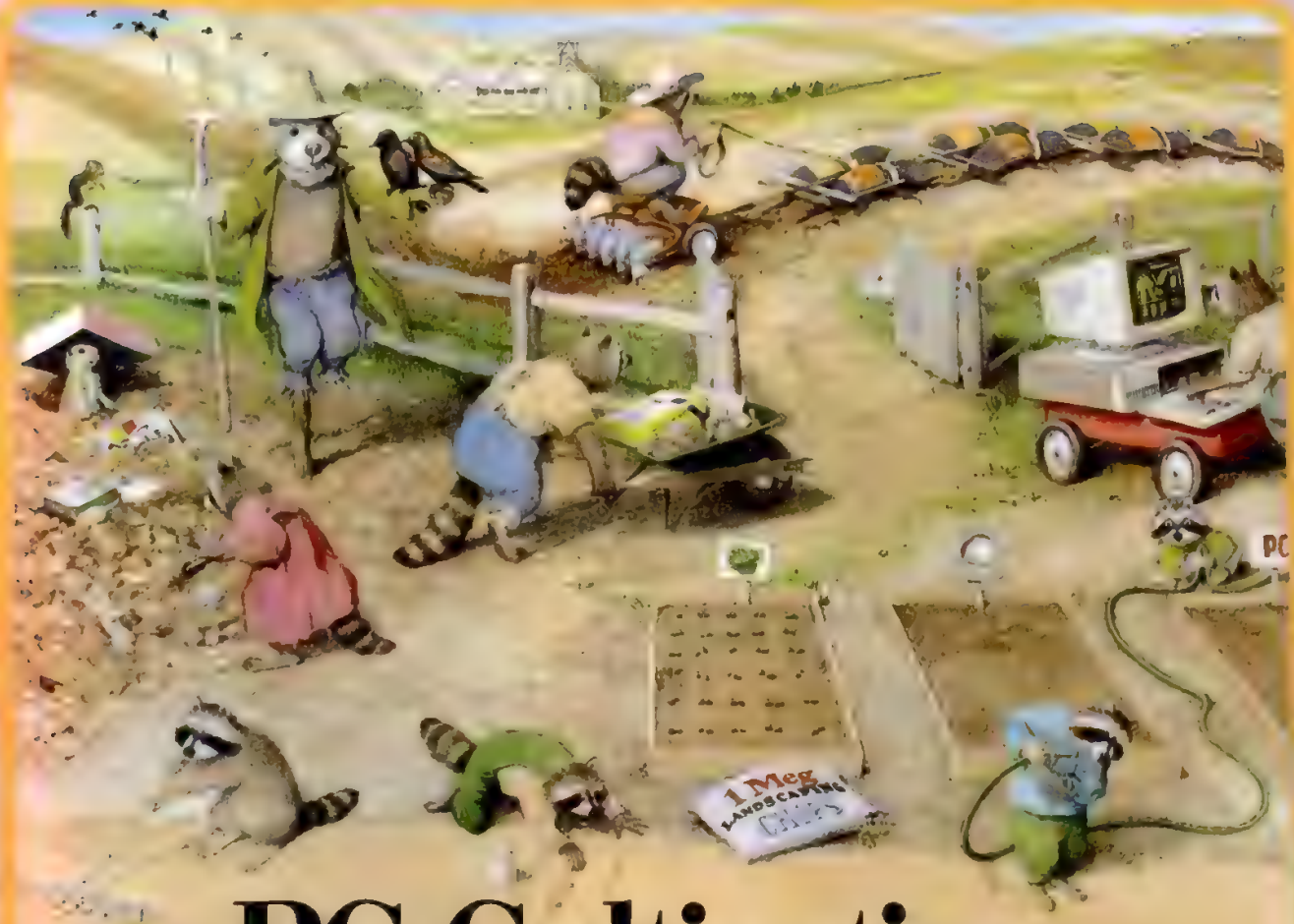

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Every NetFrame contains at least one central system processor. The system processor used in the $22,500 NF100 and the $35,000 NF300 is a 25-MHz 80386; a 25-MHz 80486 is used in the $45,000 NF400. Each NetFrame must also have at least one I/O processor, powered by an Intel 80376. The 80376 is the protected-mode-only version of the more familiar 16-bit 80386SX, and is more often found in industrial control and other embedded applications. All processors in the system communicate through shared memory.

In the future, the systems will also contain one or more processors for operating server-based applications. As of this writing, NetFrame Systems is still developing applications processors. Plans call for these to be powered by a 25-MHz 80486 and to come configured with at least 8MB of cached RAM. Applications processors will interface to the central system processor through the same DS logic used by I/O processors (described below). Until the applications processors become available, server-based applications will have to run on the central system processor.

Another type of processor—the service processor—helps out with the configuration and maintenance of all NetFrames. This 8088-based computer is mounted on the central system processor's board and controls the three-button LCD console at the top of the cabinet. The service processor also operates NetFrame's telephone notification system, which calls to tell you when your server is down.

The vertically mounted central system board rests at the rear of the cabinet. Besides the 386 or 486 processor, the board contains an 80387 math coprocessor, a custom-controlled 32K static RAM cache, and NetFrame-designed ASICs (application-specific integrated circuits) to handle both the memory bus and the separate, proprietary, hierarchical I/O bus. Slots for memory cards are found here, as well as slots for mounting I/O or applications processors.

The NF100 can house up to two memory boards and three I/O or applications processor boards. The NF300 and NF400 ac-

With a base price of $22,500, the NetFrame NF100 is at the low end of NetFrame's powerful family of file servers. The NF100 can hold up to four 25-MHz 80386s and four hard disks, and with an optional expansion cabinet, the system can handle an additional 17 hard disks. There is no keyboard or monitor; the NF100 is operated by using a PC as a remote console (NetFrame has special software for the task). One unique feature of the system: an 8088-based service processor is mounted on the CPU card just to keep track of system diagnostics.

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commodate double the number of memory boards and up to eight I/O or applications processor boards. Memory can be added to the central system processor using proprietary 8MB or 16MB memory cards; the minimum memory configuration for the NF100 is 8MB, while the NF300 and NF400 require at least 16MB of RAM. Any model NetFrame can use up to 64MB of RAM. NetFrame memory is self-correcting through the use of a 7-bit/word error check code (ECC) scheme, managed by the ASIC that controls the central processor's access to shared memory.

Access to shared memory by I/O and applications processors is controlled by NetFrame-designed DS (data server) ASICs. Each DS chip (there are two on the NF100 and four on the larger models) controls a separate high-speed 16-bit bus that implements shared memory access through simple time slicing rather than a complex arbitration scheme. The time-slicing strategy divides bus access linearly among the DS ASICs in the system.

MAINFRAME SIMILARITIES

The NetFrame computer's mainframe-like quality truly comes to light when you look at how the I/O processors are designed to work. Their job is to acquire data from relatively low-speed devices, queue it, and hand it up to the central system processor at memory speed. The reverse occurs when data needs to be presented to or stored on the low-speed devices. In general, the system provides the sort of intelligent handling of I/O chores found in mainframes. The I/O processors control logic, and data concentration relieves the central system processor of dealing with single-byte data accesses, LAN protocols, or the current location of data on a disk drive.

The NetFrame NF100 presents a neat solution for an organization that needs lots of servers.

To do that job, each I/O processor board contains, besides the 16-MHz 80376, 1MB of RAM and a custom DSI (DS bus interface) chip set that keeps it talking politely to the DS chip on the central system board. The I/O processor also includes sufficient connection hardware to keep a NetFrame communicating with its own world. The outside LAN world is serviced through an Ethernet connector; an ordinary RS-232 connector is used for printers and other serial devices, and an RS-422 connector is there for LocalTalk networks. A Token-Ring edition of the NetFrame I/O processor is also in the planning stage.

A high-speed, 8-bit SCSI interface on each I/O processor board controls disks and tape drives. The SCSI port is itself controlled by the 80376 and can be used by that processor for small-volume data transfers (as in any ordinary PC). In such a case, data is acquired, then queued in the I/O processor and handed off to shared memory using the DSI/DS logic; the reverse happens when data is written to the disk. Large-volume transfers are serviced more rapidly by connecting the SCSI port to the NetFrame's shared memory via DMA (direct memory access) using specialized circuitry in the DSI chips.

A way for PC users to share and share alike.
And share and share what's not alike.

Disk drive size and organization are flexible in NetFrame systems. The smallest single-drive system in an NF100 cabinet contains a 190MB SCSI disk, but a typical configuration will contain at least two disks of 500MB or better.

Multiple drives can be run by one I/O processor and either chained together to look like one drive, run separately, or linked in a disk-mirroring scheme to provide fault-tolerant data integrity. Alternatively, multiple I/O processors can each operate single or multiple drives, or an I/O processor can be installed with no disk drives attached to its SCSI port; as long as one processor has access to the drive(s), the data will be available using NetFrame's shared-memory scheme.

SUITABLE OPERATING SYSTEMS

You operate the NetFrame using a PC as a remote console. Currently Novell's *NetWare 386* is the only LAN operating system available for the new computers; NetFrame has provided a *Microsoft Windows*–based remote console interface. *LAN Manager*, Version 2.0, is scheduled for implementation on the NetFrame, as is Banyan's *VINES*.

NetWare provides a good model of how all network operating systems will operate on NetFrame computers. The asymmetric design requires that *NetWare*'s main kernel be installed on the central system processor. Individual, low-level device drivers are installed on I/O processors, and *NetWare*'s server-based applications (Network Load Modules, or NLMs) can be installed either on the central system processor or on an applications processor.

NetWare runs normally on the central system processor. Only when an I/O request comes up do things change. When a request from an attached workstation comes in, the I/O processor receives it, formats a message to the *NetWare* kernel, and places the message into a queue in shared memory where the central system processor picks it up and processes it. The reverse happens if the server needs to request data, and any large blocks of data get transmitted through buffers in shared memory. When applications processors are available, an NLM or OS/2 application can be installed on a dedicated or shared server.

The NetFrame presents a neat solution for an organization that needs lots of servers. You can put the equivalent of several into one NetFrame box; how many depends only on whether you buy the NF100, NF300, or NF400. Additionally, the NetFrame family has a stable and well-accepted software complement in *NetWare 386*, and you can expect Novell's server-based applications to become as well accepted as those of *LAN Manager*. ■

FACT FILE

NetFrame NF100
NetFrame Systems Inc., 894 Ross Dr., Sunnyvale, CA 94186; (408) 745-0633.
List Price: With 25-MHz 80386 processor, 8MB RAM, 380MB hard disk, I/O Server Board/E, System Administration Software, Server Activated Maintenance, $22,500; with 16MB RAM, 760MB hard disk, Token-Ring I/O Server Board, $31,000. Model NF300 with enhanced expansion capabilities, $35,000. Model NF400 with 25-MHz 80486, $45,000.
In Short: The unusual-looking NetFrame box holds up to four 25-MHz 80386s in its least expensive NF100 configuration. More-expensive models offer greater expandability coupled with more processing power.

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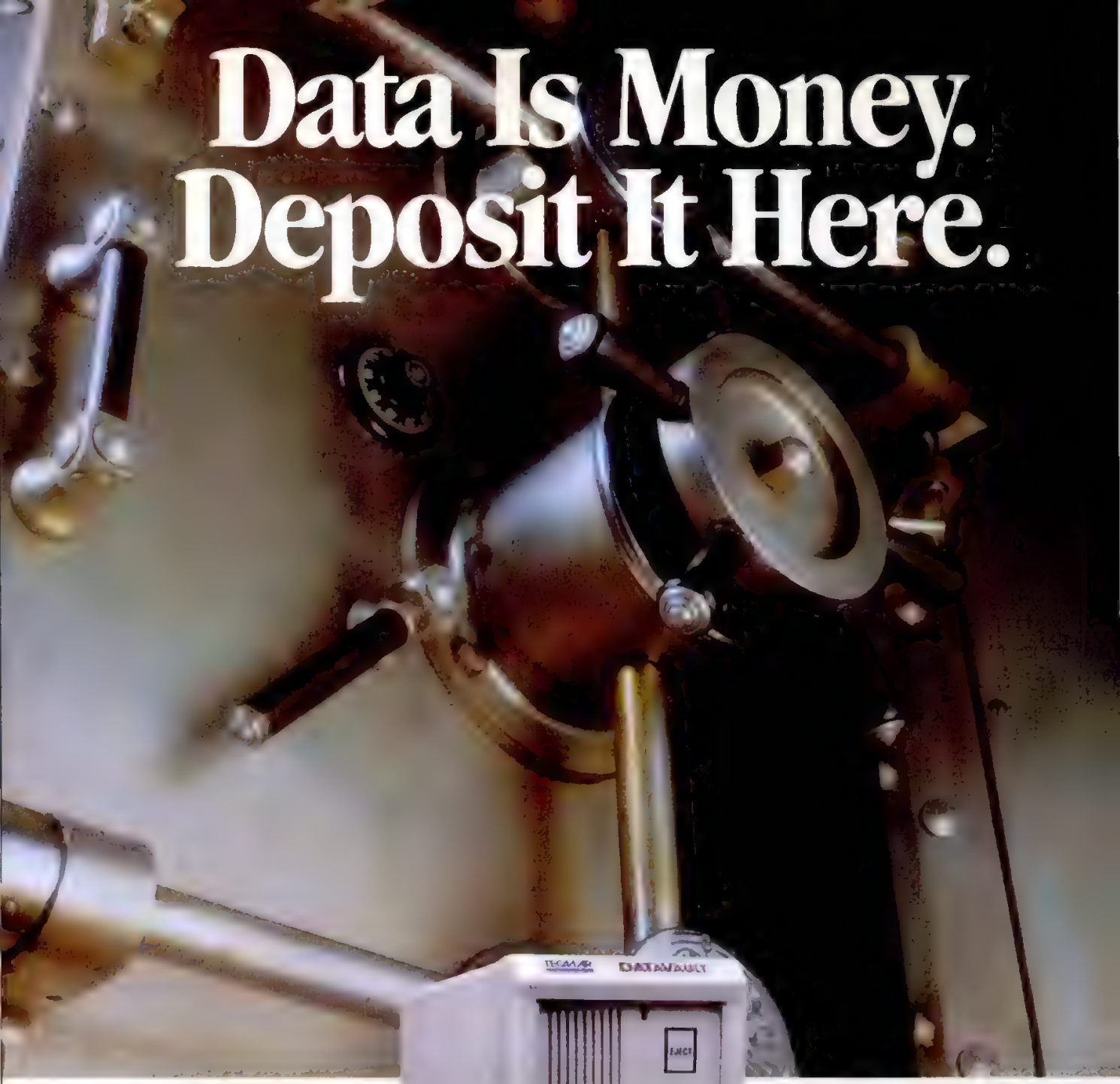

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32-Bit LAN Adapters Break I/O Bottlenecks

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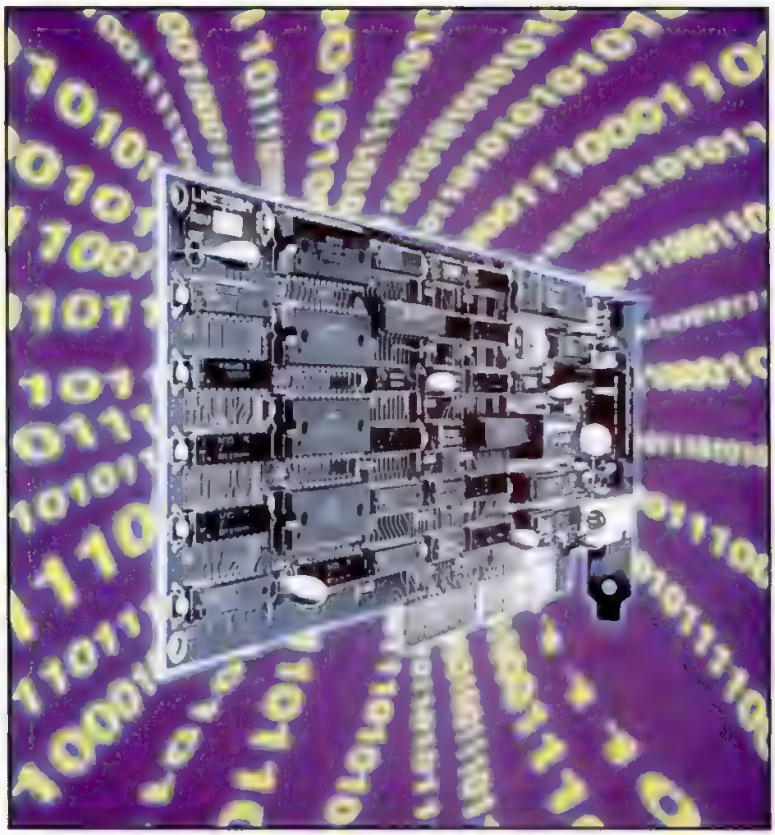


PHOTOGRAPHIC ILLUSTRATION BILL LONGCORE

BY MIKE BYRD

Today's advanced microprocessors can do what it took a building full of highly specialized computers to do just ten years ago. Speeds have risen from the 4.77 MHz of the 8086 to the 33 MHz of the 80386. Nevertheless, many people still ask, "If the chips are really going so much faster, why do I still have to wait so long?"

THE LAN SURVIVAL GUIDE

Why indeed? The very innovation that got us started has become part of the problem for many LAN users. The CPU chip, the work-

horse of the computer, has become so speedy that it's now the cause of a bottleneck in many of today's fast systems.

You have to remember that the CPU makes all the memory requests, manipulates the data, and transfers the results to peripheral devices and cards. Everything filters through it. Delays used to be caused by the inability of the CPU to keep up with the requested tasks; original 8-bit bus cards had no problem keeping up with the CPU.

With the advent of super-fast 386 chips and software like *NetWare 386* to take full advantage of their instruction sets, however, the picture has changed. Electronic traffic jams have become common. The 386 effectively moved the I/O bottleneck from the CPU to the peripheral cards on the bus. This I/O delay is the hesitation you sometimes see when you work on a LAN.

We need only look at Industry Standard Architecture (ISA) speeds to find the culprit. Systems built around the ISA (classic AT) bus use an 8-MHz, 16-bit data path. When 386 and 486 processors shuttle data in and out of memory in 32-bit chunks at speeds as high as 33 MHz, something has to give. Basically, the current I/O environment has some catching up to do.

IBM first faced this challenge with its Micro Channel architecture (MCA) back in 1987. A year and a half later, nine hardware industry leaders, including Compaq and Zenith, banded together to develop the Extended Industry Standard Architecture (EISA). Both EISA and MCA bus designs provide a 32-bit connection with the CPU and offer a substantially greater bandwidth than the ISA bus. Furthermore, both EISA and MCA support bus master cards, which off-load processor-intensive functions from the CPU.

SIMPLIFIED ANATOMY

Normally, the file server in your LAN is your fastest computer and holds your largest hard disk. Most, if not all, of the data for the network resides there. When your workstation needs data from the server, it generates a request, formats it into a data packet, and sends the data over network cabling into the server. The request enters the server through a LAN adapter card, which transfers it to memory.

If you use a computer with a classic AT bus, the CPU reads the memory and gets the data from the applicable drive. The data travels through the bus to the CPU, which transfers it to memory and then sends it out to the LAN adapter card. There it is reformatted into data packets and sent back to your workstation.

MCA or EISA systems allow shortcuts. First, their buses, which are two or four times wider than that of ISA, increase throughput significantly. Both MCA and EISA offer a burst mode that lets data-transfer from bus cards to memory (and vice versa) take place at the speed of the processor.

Bus mastering is another little trick that can eliminate the LAN bottleneck altogether. Managing high-powered peripherals can overburden the CPU and slow system throughput. A bus master is itself a computer—an expansion board with its own processor. Typically it uses an 80186, 68000, or other relatively low-processing-power chip. An intelligent peripheral, the bus master takes control of the bus, reading from or writing to system memory or to another I/O device without involving the CPU. Remaining independent of the data transfer, the CPU continues with other tasks. Throughput improvement can be huge (see the diagram "The Bus Master Performance Boost").

NOT FOR EVERYONE

Obviously, you don't need 32-bit EISA or MCA burst-mode bus-mastering LAN adapter cards in every workstation. You use them in file servers and perhaps in a few very-high-powered graphics workstations where you might be running CAD or engineering programs. You also need to consider placing one of these cards in a workstation if you frequently transfer megabytes of data to it from your file server. Otherwise, the rest of your networked PCs can continue to run quite well with standard 8- or 16-bit LAN adapters.

Of course, the maxim "If it ain't broke, don't fix it" serves most LAN users well. If your LAN is already operating well with minimal delays, leave it alone. However, if you are encountering long delays or expect a significant increase in your server's workload, you should consider fine-tuning your server's hard disks, network interface card, and CPU. If you are experiencing communication errors (duplicate requests, packet collisions) and are sure your cabling is not the culprit, there's a good possibility that your system is being slowed by your network adapter card. And if CPU use is running above 50 percent, you

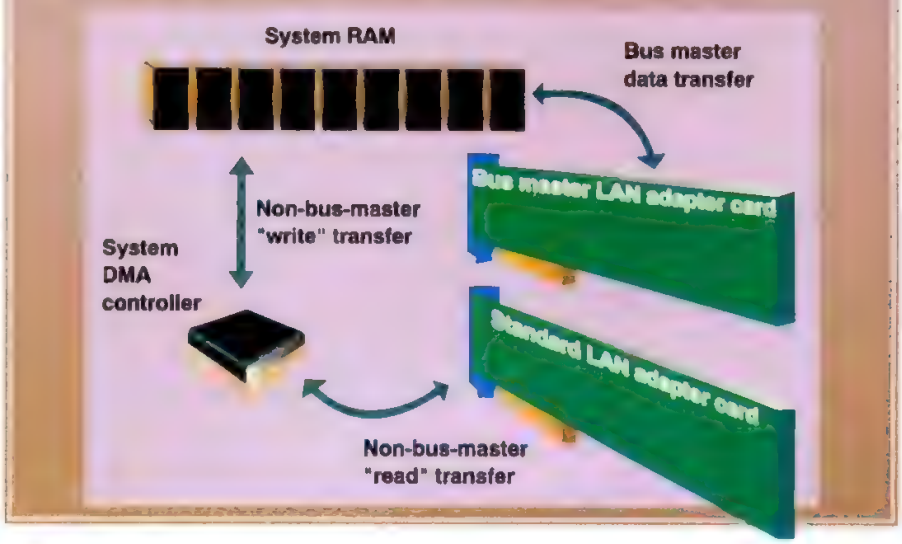
THE BUS MASTER PERFORMANCE BOOST

by Mike Byrd

Bus mastering is not a new concept. In fact, the microprocessor is usually the "bus master" in any PC since it controls the activity on the external system bus. The Direct Memory Access (DMA) controller also acts as the bus master in many operations.

Almost all network adapter cards use DMA to move data to and from the PC's memory. Under DMA, the data moves in two hops: one "read" transfer from the card and one "write" transfer into system memory. During this transfer, the DMA controller first disables, then mimics the microprocessor. The microprocessor suspends all operation while the DMA controller is in charge. This technique is better than forcing a hardware interrupt that would cause the processor to store its actions and turn to another task, but it still slows down system processing.

Bus master adapters don't use the DMA controller. Instead, they mimic the microprocessor and transfer data directly into system memory. Some other network adapters move data using a memory segment they share with system memory, but they still must interrupt the processor to make it read data. ■



should start looking for a new server with a 386 chip running at a minumum of 25 or 33 MHz.

If you are buying a new system, assume that the demands on network usage are going to be greater than you originally forecast. If you can, you should opt for a system that is more powerful than you think you'll need. After all, an extra $1,000 that gets you a fast MCA or EISA server, a 32-bit network adapter card, or a better hard disk will pay for itself quickly in improved productivity.

WHAT'S OUT THERE?

When we talk about 32-bit LAN adapter cards, we're talking about leading-edge technology. Few of these cards are currently on the market, and many are still in the development and testing stage. Later this year, PC LAN Labs will undertake a large comparative evaluation pitting these cards against one another. Until then, here is a brief look at some of the 32-bit EISA and Micro Channel LAN adapter cards you can buy today.

Cogent E/MASTER-II Series

Cogent Data Technologies offers the E/MASTER-II series of 32-bit Ethernet cards with a card for everyone, covering all bets by having versions for the ISA bus (E/MASTER-II, $895), the EISA bus (E/MASTER-IIE), and the MCA bus (E/MASTER-IIM).

The E/MASTER-II family uses Intel's 32-bit LAN coprocessor chip set to implement a common bus master design for the ISA, EISA, and MCA buses. This design allows balanced performance across the network by supporting various buses with a common Ethernet design.

The E/MASTER-II achieves 8-megabit-per-second bus data-transfer rates on the ISA bus. It is unique in being an ISA LAN adapter card that also uses bus mastering, and though it is a 32-bit LAN adapter card, it can also use the ISA 16-bit data path.

Both the E/MASTER-IIE and the E/MASTER-IIM achieve 33-megabit-per-second bus data-transfer rates. All three cards are fully IEEE 802.3 compatible and FCC Class B certified. Drivers are available for DOS, *LAN Manager*, and *NetWare*.

Madge Smart 16/4 EISA Ringnode

The Madge Networks' Smart 16/4 EISA Ringnode is an IEEE 802.5 and IBM-compatible token-ring LAN adapter card for all EISA computers. It features a switchable 4- and 16-megabit-per-second token-ring data-transfer rate with direct connectivity to the token-ring network.

The Intel 82355 BMIC provides bus master data transfers up to a burst rate of 33 megabits per second, and the card holds 128K of on-board memory.

EISA architecture allows multiple network adapters in a server to share the network traffic load. Madge Network's software places the token-ring transport software onto the Smart 16/4 EISA Ringnode itself, where a Texas Instruments TMS380C16 communications processor executes it. This allows multiple Smart 16/4 EISA Ringnodes in an EISA server to increase performance without creating an extra load on the CPU.

The Smart 16/4 EISA Ringnode is completely software configurable: there are no jumpers or switches on the board itself. Madge Networks furnishes software for NetBIOS and *NetWare* and provides hardware drivers for maximum performance. The 16/4 EISA Ringnode costs $1,495.

Mylex LNE390

Mylex, most notably a motherboard manufacturer, believes in a system approach to any problem. Instead of just providing PC LAN Labs with a 32-bit LAN adapter card, the company also sent a 486 EISA motherboard and a sizzling bus-mastering SCSI disk controller with 4MB of cache memory.

As for the LNE390 itself, a National Semiconductor NS8390 network interface controller runs the card and supports data buffering as well as communications management. The card performs all of the Ethernet housekeeping and communications functions independently of the host processor. The LNE390 holds 32K of 32-bit, zero-wait-state memory. These data buffers can be accessed by using either the host CPU or the NS8390 at any time.

To send a data packet, the host CPU copies the data into one of the buffer spaces and then uses I/O instructions to tell the NS8390 to send the packet. The NS8390 performs this operation independently, automatically resending the packet up to 16 times if an error is encountered. Once the operation is completed, the NS8390 signals the host CPU through a single interrupt, and the host program can initiate another transfer. A data receipt operation is also handled independently of the host CPU.

Incoming data loads are automatically assigned buffer space. An interrupt is sent to the host CPU only when the receipt is complete.

The Mylex method of sharing memory differs from the direct memory access approach on most other boards. Mylex believes communication activity in an LAN environment consists mostly of a large number of small data packets. In fact, a typical data packet can be as short as a dozen bytes. Since DMA incurs a disproportionate amount of overhead when compared with shared memory (for small data packets), using the NS8390 instead of a dedicated CPU chip and bus mastering translates into a lower-cost adapter card.

The LNE390 supports both thick and

FACT FILE

Cogent E/MASTER-II Series
Cogent Data Technologies Inc., 175 West St., P.O. Box 926, Friday Harbor, WA 98250; (206) 378-2929.
List Price: E/MASTER-II, $895.

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Madge Smart 16/4 EISA Ringnode
The Madge Networks Inc., 1580 Oakland Rd., Suite C-206, San Jose, CA 95131; (800) TR-MADGE, (408) 441-1300.
List Price: $1,495.

CIRCLE 427 ON READER SERVICE CARD

Mylex LNE390
Mylex Corp., 47650 Westinghouse Dr., Fremont, CA 94539; (800) 446-9539, (415) 683-4600.
List Price: $450.

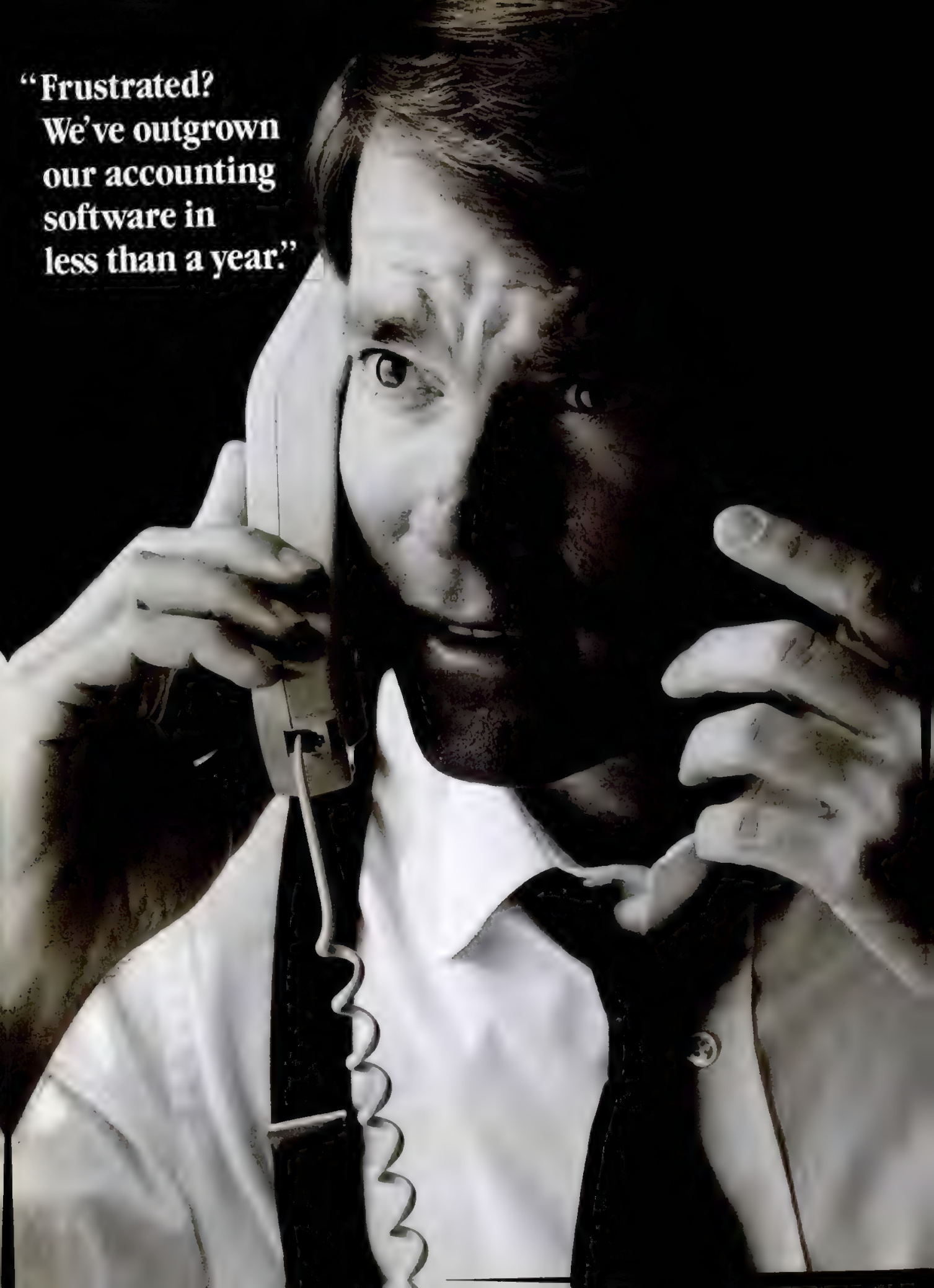
CIRCLE 428 ON READER SERVICE CARD

Novell NE3200
Novell Inc., 122 East 1700 South, Provo, UT 84606; (800) 833-7693, (801) 379-5900.
List Price: $1,295.

CIRCLE 429 ON READER SERVICE CARD

Proteon ProNet-4/16 Model p1990
Proteon Inc., Two Technology Dr., Westborough, MA 01581; (508) 898-2800.
List Price: $1,195.

CIRCLE 542 ON READER SERVICE CARD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thin Ethernet interfaces, as well as *Advanced NetWare 286* and *NetWare 386* software. It is fully IEEE 802.3 compatible and costs $450.

Novell NE3200

Novell introduced the first 32-bit bus master Ethernet network adapter built to the EISA specification, the NE3200. Jointly developed with Compaq, it complements Novell's *NetWare 386* LAN operating system and the new generation of EISA-based PC systems. Novell's marketing strategy is twofold: first, to improve and support the departmental workgroup networks (the company's traditional market), and second, to expand into the client/server database arena, previously available only to mainframe and minicomputer users. Novell designed the card to free up CPU and bus cycles, thereby taking full advantage of the EISA bus specifications.

The NE3200 includes an on-board Intel BMIC that gives the adapter the ability to read and write directly between its memory and computer memory in a 33-megabit-per-second burst mode. It is an intelligent card driven by a 10-MHz 80186 processor with 48K of on-board memory.

The card is software configurable, with options that allow six or more cards to be installed in one server. To support both thin and thick Ethernet cabling, it has a standard BNS connector and on-board transceiver for thin Ethernet and a 15-pin D-shell connector with an external transceiver for thick Ethernet, twisted-pair, or fiber-optic cabling. It offers full IEEE 802.3 compliance and costs $1,295.

Novell's NE3200 can read and write to computer memory in a 33-megabit per-second burst mode.

Proteon ProNet-4/16 Model p1990

Proteon's new ProNet-4/16 Model p1990 LAN adapter card supports both 4-megabit-per-second and 16-megabit-per-second token-ring networking for EISA computers. It features bus master implementation, 33-Mbps burst-mode DMA capability, and 128K of on-board buffer memory. The p1990 is software selectable for 4- and 16-megabit-per-second network speeds and transmission media. This feature allows users to configure the network's speeds without removing the adapter to set switches and jumpers manually. You can use either unshielded twisted-pair (UTP) or shielded twisted-pair (STP) cabling.

The p1990 supports *Advanced NetWare 286* and *NetWare 386*, *LAN Manager*, and *IBM PC LAN*. It is fully IEEE 802.5 and 802.2 compatible and FCC Class A certified. Its retail price is $1,195. ■

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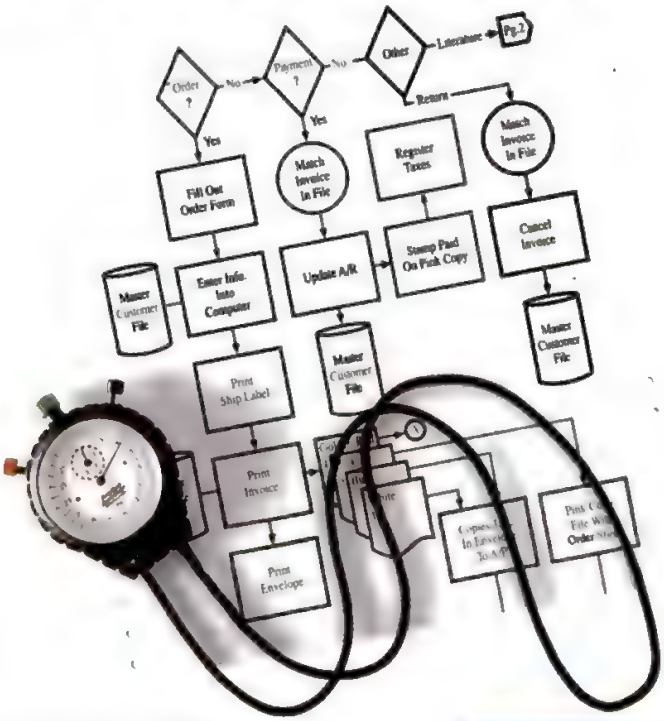

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Note: Information on this chart is based on published materials.

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Network Printing Without Pain

While it's true that NetWare comes with its own utilities for managing printers on a LAN, it's also true that you can do much better.

PHOTOGRAPHIC ILLUSTRATIONS: BILL LONGDORE

BY ALFRED POOR

You may wonder why people pay extra to replace things that come their way free, but they do. They shell out money for new car stereos to replace the standard Detroit squawk boxes, private education instead of public schooling, and optional printer-sharing tools instead of the bundled Novell *NetWare* utilities.

THE LAN SURVIVAL GUIDE

In this review, we take a look at seven packages that aim to offer enough extra functionality and value above *NetWare*'s normal printer-

sharing features to convince you to plunk down extra cash to get their benefits.

There's no question that *NetWare* has a dominant lead in the LAN market, but there are serious limitations in *NetWare*'s ability to share printers. Older versions had SPOOL and ENDSPOOL commands that have been replaced with CAPTURE and ENDCAP, but the problems remain.

Sharing a printer sounds like a great way to get more value from an expensive peripheral, but one fundamental problem is that all shared *NetWare* printers must be attached to the file server. For networks connecting a small handful of workstations that's not a problem; but consider the case of a larger network, where dozens of workstations scattered around an entire floor of an office building share a single server. Unless the server is located at the center of the space, some users will have to walk from one side of the building to the other to collect a print job. If the network spans multiple floors, the problem is even greater.

Another *NetWare* limitation is that the CAPTURE and ENDCAP commands must be issued at the DOS prompt. You can choose a time-out feature to pause in a print job so that you don't have to leave your application, but this poses new problems. Set the time-out too short and you'll risk having one print job interrupted by another if the first job pauses too long while printing. If you set the interval too long, you run the risk of tying up your printer resources for inordinate lengths of time, losing the productivity increase you had hoped to gain.

TO THE RESCUE

Enter LAN print utilities. They address these problems in two significant ways.

First, they enable "print servers"; these are workstations with local printers that can be shared with other workstations on the LAN. You can set up one printer for a cluster of workstations, and they can all send their output to it regardless of their proximity to the file server.

Second, most packages offer pop-up print-control programs. These vary in their capabilities, but in general they allow you to send configuration commands to a printer, signal the end of a print job, or manage print jobs that are already scheduled in a print queue—all without leaving your current application.

Programs in this category accomplish their tasks in a number of ways. In general, they intercept the print stream before it gets to the workstation's printer port and direct it to a spooling file. Depending on a given program's capabilities, this file might end up on a local hard disk or on the print server's disk, but in most cases the program will create it on the network's file server, just as *NetWare* does. This spooling file is then placed in a print queue, which keeps track of where it is to be sent.

The task of directing a print job to a spooled printer is accomplished at the workstation, and the TSR requirements for pop-up access to this control vary among the programs. In most cases, you can simply issue commands at the DOS prompt if you decide that you do not have the memory to spare for the added convenience. At the print-server end, a TSR handles the task of communicating with the file server and workstations to access the spooled print jobs. Some of the programs we tested also offer either pop-up or dedicated programs for managing the print queues, including tasks such as start/stop and changing priority levels.

Each utility offers its own special features as well. Some facilitate electronic messages between workstations. Others let you easily select printers on the file server or printers on print servers. And some even let you access another workstation's hard disk the way a DOS-based LAN does.

In fact, some of these features have become so popular that Novell is now incorporating them in its *NetWare 286* products. As of February 1990, all new copies of *Advanced NetWare 286* and *SFT NetWare* 2.15 include new VAPs (value-added processes), one of which provides print-server features. This adds important new capabilities to *NetWare*, such as increasing the number of shared printers to 16 and allowing the shared use of printers attached to workstations. These *NetWare* enhancements also make it possible to notify users automatically when their print jobs are finished.

These additions to *NetWare* don't make third-party products obsolete. Novell is not selling the additional features as a separate product. You must either purchase a new Novell system or upgrade an older one to get the added features; the only customers who can get the new VAPs separately are those who subscribe to Novell's *NetWare* upgrade program, Assurance.

Many users will find third-party solutions less expensive than a system upgrade. Also, most of the third-party products offer more features than the new Novell system: pop-up operation, sophisticated queue controls, and support for more than 16 printers. Users of the Entry Level System (ELS) versions of Novell will not have access to the new Novell features, so they will have to rely on third-party programs.

The seven products we tested are all designed to make it easier to share printers when using Novell's *Advanced NetWare*. All provide different degrees of access to the shared printers from workstations, and most include a pop-up program that offers a menu of choices. All but one of the programs also make it possible to share printers attached to a workstation. The exception, *Saber Print Manager*, is included because it provides a useful alternative for smaller networks that do not need the print server feature.

There are many other products that provide overlapping or complementary features (see the sidebar "Alternatives for Successful LAN Printing"). For example, there are devices that allow workstations to share printers through an electronic intelligent-switching unit, and there are printer-configuration utilities that can be used on a

EDITOR'S CHOICE

- **PrintQ LAN**

If you want a LAN print utility that you won't outgrow and that can furnish a range of powerful features for both small and large networks, then *PrintQ LAN* is the clear choice.

It costs more than some competitors, but none offer all the features that *PrintQ LAN* does. The fact that an organization can incorporate it into custom applications makes it even more attractive. Since there is also a standalone version, *PrintQ*, an organization can standardize its networked and individual print-queue management.

If you don't need all that flexibility, *LANsmart/NV* is a reasonable runner-up. It still has some rough edges that need to be polished, but the speed it's found by taking its own path to printer sharing, as opposed to simply tacking itself onto *NetWare*'s existing services, makes it a winner.

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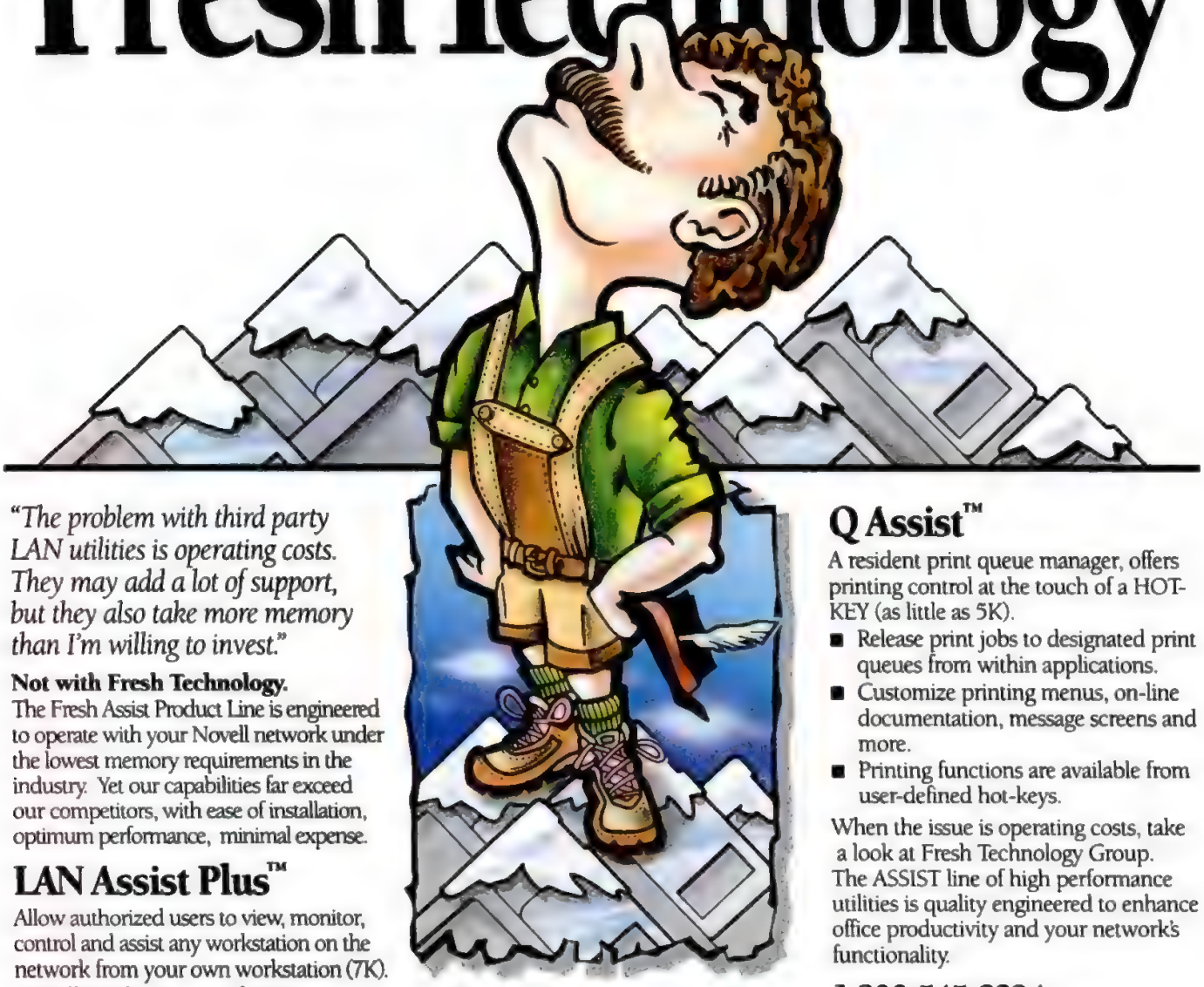

"The problem with third party LAN utilities is operating costs. They may add a lot of support, but they also take more memory than I'm willing to invest."

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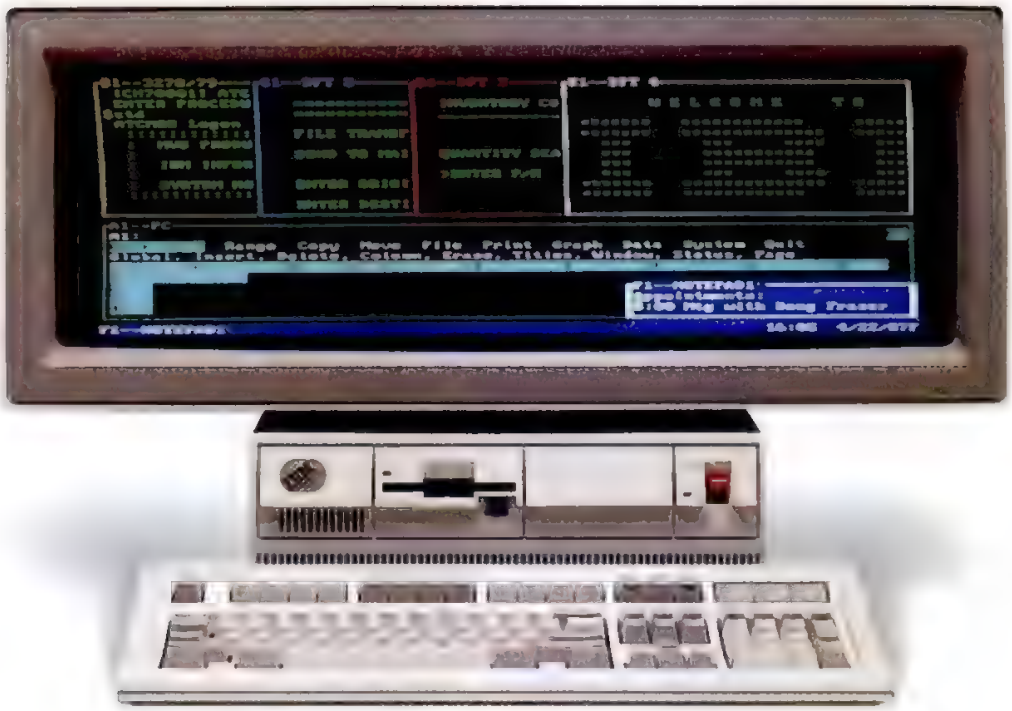

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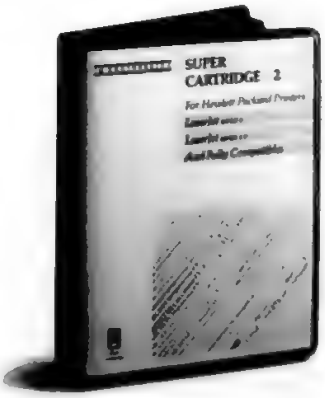

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CIRCLE 325 ON READER SERVICE CARD

network. There are even products that hook directly into your network and accept print jobs from workstations if you don't want to dedicate an entire workstation to the role of a print server. You can also find products designed to run under *LAN Manager* instead of *NetWare*.

The packages tested here, however, all run with *Advanced NetWare 286*, which we installed on an IBM PS/2 Model 80 file server. We used Ethernet cabling to connect six IBM workstations—five used as workstations and the sixth as a print server. We tested them for print speed under increasing loads, and we compared their various features, paying special attention to the details that give each one advantages over the others.

Each of these packages offers something not available through the standard *NetWare* printer services—even the version that Novell is shipping now. When it comes to sharing printers on a *NetWare* network, there are times when paying extra still makes sense.

LANsmart/NV

Every LAN print utility has some feature that distinguishes it from its competitors, but in most cases there are more similarities than differences. *LANsmart/NV* from D-Link Systems (which also sells the *LANsmart* operating system; see "Making Do with DOS" in this issue) is a sharp contrast from the other "me too" products. This $595 package has some unique features—some good, some not so good—that make it stand out from the rest.

Like most of the other utilities in this category, *LANsmart/NV* is licensed on a per-server basis. It has the highest price in the group; even *PrintQLAN*, which is priced *per user*, is less expensive for a 20-user license. So what do you get for this higher price?

One thing you don't get is a fancy front end for *NetWare*'s print services. While other programs rely on *NetWare*'s print-job database, *LANsmart/NV* takes its own path to printer sharing. In this program, the workstations talk directly to each other, which means that one station can send a print job directly to a shared printer attached to another workstation.

This independent approach makes a number of interesting things possible. Depending on your configuration, you can arrange to have your print jobs spooled either on the server or on the workstation with the shared printer, thereby reducing the load of the server. If you have enough memory in the print server, you can set up a RAM-disk and send spooled print jobs there for faster processing.

The advantages do not stop there, however. Since the program does not rely on *NetWare* services, you can log out of *NetWare* on the print server, but it will still be able to receive print jobs from other stations. The operator of a print-server workstation can leave the machine unattended without fear of other users gaining unauthorized access to the network. (Other systems suggest that you create a "dummy" user with no rights and log on to that account if you must leave the system unattended.)

LANsmart/NV offers even more. You can share hard disks located on other workstations, which can be a significant boon for complex database designs or for a live copy of shared files if you can't access the set stored on the file server. *LANsmart/NV* also has some added features for messages and a chat mode between workstations.

DETAILS, DETAILS

With all its features, there are still some missing details. Although you can run the main *LANsmart/NV* as a TSR (terminate and stay resident) program, you cannot reconfigure its hotkey assignments. As a TSR program, it loads itself into extended memory to free up more space, but it can't use expanded memory—a significant factor because *LANsmart/NV* has the largest RAM requirement of all the products that we tested. Despite LANsmart/NV's variety of queue-control and workstation-communication features, the program cannot automatically notify you when a given print job is finished.

The program's performance figures were simultaneously high and low. It was the slowest program when sending its print jobs, yet it was the fastest for actually getting the pages to drop into the output bin. This speed means little in comparison with the top three products, but it was (on average) 15 percent faster than the field.

Installation is also a mixed bag. Like some other products tested here, *LANsmart/NV* requires that you call to get a number that unlocks your copy of the program, but it isn't so easy. I started calling at 10 A.M. eastern standard time, and was not able to reach anyone at D-Link who could help me until almost noon. The moral is that either East Coasters should postpone installing *LANsmart/NV* until the afternoon, or D-Link should shift work schedules so it can provide technical support across all four time zones.

The installation and serialization instructions, divided inconsistently among three documents, were also a bit confusing. However, once serialized and installed, the product was easy to configure and operate. Users at all levels should find *LANsmart/NV* easy to work with, since you can run it either from the DOS prompt or through straightforward menus.

Once *LANsmart/NV* is installed, you can begin to enjoy its versatility. The program's overall performance is good, and its shortcomings fall mostly into the minor-annoyance category. In short, it's one of the top choices in the field and certainly worth the money.

FACT FILE

***LANsmart/NV*, Version 1.0**
D-Link Systems Inc., 5 Musick, Irvine, CA 92718; (714) 455-1688.
List Price: $595 per file server.
Requires: Novell *NetWare* 2.1 or later; on server: 70K RAM with extended memory, 140K RAM without extended memory, 30K for printing only with extended memory, 100K for printing only without extended memory; on workstation: 2K RAM with extended memory, 70K RAM without extended memory; DOS 3.1 or later.
In Short: *LANsmart/NV* is powerful, flexible, fast, and worth the extra cost compared with some of its competitors. Its minor flaws shouldn't deter you from considering it a top candidate.

CIRCLE 419 ON READER SERVICE CARD

LANSpool

If you like the way *NetWare* handles your print spooling but want more, then *LANSpool* from LANSystems could be the product for you. This $395 product is built on *NetWare*'s PRINTCON database facilities, yet goes far beyond to offer some useful features.

Most important is *LANSpool*'s ability to share printers hooked up to a workstation. Unlike some other products based on *NetWare*'s spooling, *LANSpool* is able to continue operating a shared printer on a workstation even after the computer has

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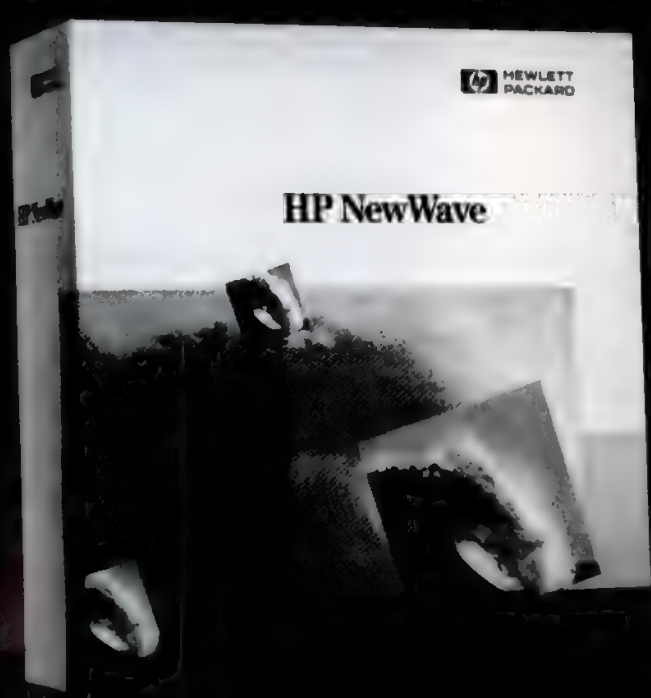

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CIRCLE 151 ON READER SERVICE CARD

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been logged off the network. This can be valuable for network security.

The program can run in one of two modes. Most users configure the print server to run in nondedicated mode; since the print-server program requires only 2.5K RAM per shared printer, there is still plenty of room to run full applications at the same time. This mode requires installing a VAP (value-added process) into your *NetWare* server—a process that requires bringing down the server and rebooting. If you want the security of a dedicated print server, you can run the program directly on the workstation that has the shared printer (or printers) without need for the VAP.

LANSpool had one of the least painful installations of all the products we tested. The manual is clearly written, with all steps described in detail. The instructions even illustrate the various *NetWare* utilities you must use in the course of installation so that you don't need to sort through a 3-foot stack of red manuals to find the right Novell program booklet.

Once you have the software installed, the *LANSpool* printers act like normal *NetWare* queues for printers on the server: all the standard *NetWare* commands will work, including CAPTURE and ENDCAP. LANSystems includes a pop-up program to help you access the different print features, which makes *LANSpool* even easier to use than *NetWare*. Also, you can configure the menus in order to control the end users' options—a great help if you are responsible for managing a large network.

WHAT'S MISSING

LANSpool does suffer from a few missing features. For example, it has only rudimentary queue controls, works only with *NetWare* 2.1*x* versions, and cannot work with the older Version 2.0a or the new *NetWare 386* versions.

LANSpool performed well on our tests.

ALTERNATIVES FOR SUCCESSFUL LAN PRINTING

by Alfred Poor

We could fill another dozen pages with lists of products that provide help for LAN printing. Here is a small sampling of some typical problems and the ways that you can solve them.

■ **Windows dilemmas** The growing popularity of *Microsoft Windows* creates special problems for LAN users because *Windows* doesn't tolerate TSRs that try to pop up over it. *Windows Workstation*, from Automated Design Systems, is a bundle of utilities that includes a print-management utility for *NetWare*. It lets you route output to local or server-based printers and manage print queues from a *Windows* application. The company expects to incorporate print-server features into its version for *Windows* 3.0.($595 per ten-user license; Automated Design Systems Inc., 375 Northridge Rd., #270, Atlanta, GA 30350; (800) 366-2552, (404) 394-2552.)

■ **Integrated answers** Some products don't wait for others to provide print-server facilities. *INTO*, an integrated program from Share Data, provides word processing, database, and groupware functions in a single package that can also send its output to shared printers on workstations. ($1,499 for five users; Share Data Inc., 7400 W. Detroit St., Chandler, AZ 85226; (800) BUY-INTO.)

Indigo Software's *JetForm-Server* is designed specifically to make it easier to create, manage, and print on a variety of preprinted and custom forms. The package can also send its output to shared printers on workstations on a network. ($995; Indigo Software Ltd., 560 Rochester St., #400, Ottawa, Ontario, Canada K1S 5K2; (800) 267-9976, (613) 594-3026.)

■ **Font control** Some people simply want an easier way to configure their shared printers to gain access to various fonts and features. There are many utilities on the market, but some are designed to function on a network. These products typically supply a database of printer controls and can pop up over your regular applications so you can send Esc-command sequences to your shared printer. Some examples are *PrintRite* ($99.95; BLOC Publishing, 800 SW 37th Ave., #765, Coral Gables, FL 33134; (800) 888-2562, (305) 445-0903); *LaserMenu* ($99.95; MicroLogic Software, 6400 Hollis St., #9, Emeryville, CA 94608; (415) 652-5464); and *Nor-A-Net* ($149; Nor Software Inc., P.O. Box 1747, Murray Hill Station, New York, NY 10156; (212) 213-9118.)

■ **Direct connection** If you don't want to dedicate an entire computer to the role of print server, there are products like LANPORT that hook a printer directly into your network and accept print jobs from workstations. LANPORT is a small box, 4 by 7.5 by 1 inches, that comes with a network connector on one side and a parallel or serial port on the other. A single workstation may be cheaper if you are going to connect a few printers to it as a print server, but LANPORT will cost less if you only want to share a single printer at a given location. (From $495 to $695; Microtest Inc., 3519 E. Shea Blvd., #134, Phoenix, AZ 85028; (800) 526-9675, (602) 971-6464.)

■ **Intelligent switching** Print jobs that are sent to shared printers on a network load up network cabling, and if you are running an application that makes heavy use of other network resources, long print jobs can degrade performance significantly. A simple solution is to print locally, but then you lose the benefits of sharing printers.

A better solution is an intelligent switching device. Such units will accept input from two or more workstations and can be connected to either parallel or serial ports. Many let you use inexpensive telephone cabling to connect workstations to printers, and a few allow you to run parallel connections over distances much greater than the normal 12-foot limitation inherent in parallel interface design. There are dozens on the market, with a nearly infinite variety of feature combinations. Here are three: EasyPRINT-2 ($99.95; Server Technology, 2332-A Walsh Ave., Santa Clara, CA 95051; (800) 835-1515, (408) 738-8377); ShareSpool and MultiSpool (from $595 to $1,695; Extended Systems Inc., P.O. Box 4937, Boise, ID 83711; (208) 322-7163); and 3X Spool 16 ($279 for a starter kit; 3X USA Corp., 1 Executive Dr., Fort Lee, NJ 07024; (800) 327-9712, (201) 592-6874). ■

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FACT FILE

***LANSpool*, Version 2.0**
LANSystems Inc., 300 Park Ave. South, New York, NY 10010; (800) 458-LANS, (212) 995-7700.
List Price: $395 per file server.
Requires: Novell *NetWare* 2.1 or later (not including *NetWare 386*), 120K RAM on server, 2.5K RAM on each workstation, DOS 3.1 or later.
In Short: *LANSpool* expands on the print facilities offered by *NetWare*. It requires extraordinarily little memory but is limited in terms of which *NetWare* versions it will support.

CIRCLE 420 ON READER SERVICE CARD

It was among the fastest in output speed and time to send a print job. (There was little practical difference among the top performers in our tests.)

The program comes from a company that specializes in add-on products for *NetWare*, ranging from front-end shells to shared-document management utilities. From its intuitive interface to its lucid documentation, *LANSpool* testifies to the company's experience.

The main drawing card for *LANSpool* is its extremely low memory requirement at both the workstation and print server. Its price is midrange, but the package represents a good value in light of the options it offers. If you want a system designed to make the most of *NetWare*'s capabilities while adding some improvements of its own, then *LANSpool* is a good choice.

Network Assistant Plus

Network Assistant Plus from 3rd Planet Software carries a list price of $295 per server, which puts it in the below-average price range for this class of programs. Its features, however, compete favorably with those of the other programs reviewed here.

Unlike many of the utilities, *Network Assistant Plus* does not rely on the *NetWare* print services. By creating its own approach, the program can do things a little differently. There are pop-up programs for submitting print jobs and managing print queues, and you can reconfigure the hotkeys that call up TSR programs—even assigning the PrtSc key if you want (just tell the program you want to use the gray asterisk key on a 101-key keyboard).

Network Assistant Plus is highly customizable. The package includes a utility, NASPOOL, along with its source code in C. Programmers can use this as an example for designing their own end-user utilities and menus that will take advantage of the package's features. Not only can the program handle shared printers at workstations, it can also be used to remap drives, send messages between workstations, and even attach to other servers.

INSTALLATION GLITCH

Installation was not a snap. You need to gather some serial numbers from the product and workstation screen, then call 3rd Planet Software for a key number that will unlock the software. The documentation states that the company's toll-free number is staffed from 8 A.M. to 5 P.M. Pacific time, and I had no trouble getting the help I needed. The company also has a 24-hour bulletin board system where you can get your key number. However, part of what makes the installation difficult is that the instructions are contained in a separate update booklet that contradicts information in the main manual. 3rd Planet Software would do well to produce a consolidated manual as soon as possible.

Unfortunately, the biggest problem with *Network Assistant Plus* is its performance. It was about average in the time it took to send a print job, but once the print jobs were on their way to the print server, things slowed down. It ended up with the slowest average print time of all the products we tested, taking nearly 50 percent longer than the four fastest programs. Watching the *NetWare* server monitor revealed that *Network Assistant Plus* requires a great deal of housekeeping in managing the print-job files; it was constantly opening, writing, and closing files, which resulted in lots of server activity. Since our test print jobs were only two pages long, it's likely that the effect of this overhead would be less significant if the print jobs were longer.

On the other hand, the program offers lots of interesting and useful features. You can create custom profiles for individual workstations or groups of similar workstations. You can create menus for extensive printer control so that you can pop up and select different fonts or effects for the shared printer. And *Network Assistant Plus* is one of the few programs in this group to support all the versions of *NetWare* from 2.0 through *NetWare 386*.

Network Assistant Plus is reasonably priced and has great customization ability. It may be slower than the others, but this is most likely to be a problem with many short jobs rather than a few long ones.

FACT FILE

***Network Assistant Plus*, Version 3.20m**
3rd Planet Software Inc., 9819 National Blvd., #2, Los Angeles, CA 90034; (213) 841-2260.
List Price: $295 per server.
Requires: Novell *NetWare* 2.0 or later, 29K RAM on each workstation, DOS 2.0 or later.
In Short: *Network Assistant Plus* has a relatively low price but offers plenty of support. Since it doesn't rely on the *NetWare* print services, it can work with older versions of *NetWare* including Version 2.0. It is a bit slower than the competition, however, which could be a limitation for some installations.

CIRCLE 421 ON READER SERVICE CARD

Printer Assist

Printer Assist from Fresh Technology Group carries an improbably low list price of just $179 per server—the lowest price of any package we tested—and it's not just a stripped-down utility. Indeed, it has some unusual features that make it worth considering for a variety of applications.

There is a simple explanation for the low price. *Printer Assist* is really half of a pair. Its alter ego is a companion product called *Q Assist*. As its name indicates, *Q Assist* is designed to handle all the shared print-queue management functions, leaving *Printer Assist* to focus on making a workstation's printer available to other stations on the network.

There are other programs evaluated here that can work with *NetWare* 2.0a, but *Printer Assist* is the only one that can do this and still take advantage of the PRINTCON database features of the later *NetWare* 2.1*x* versions. You need to configure the program differently for the two sets of network operating systems, but this flexibility means that you can set up *Printer Assist* on a broader range of networks. If you are running *NetWare* 2.1*x*, you also

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FACT FILE

***Printer Assist*, Version 3.0**
Fresh Technology Group, 1478 North Tech Blvd., #101, Gilbert, AZ 85234; (602) 497-4200.
List Price: $179 per server.
Requires: Novell *NetWare* 2.0a or later, 4K RAM on each workstation, DOS 2.0 or later.
In Short: *Printer Assist* carries a low list price, focusing simply on providing access to a shared printer at a workstation.

CIRCLE 422 ON READER SERVICE CARD

must set up a *Printer Assist* print server as a named queue, which appears on the Novell print-service utilities just like the other regular *NetWare* queues.

There is little in the way of software outside the configuration programs. When you set up the print server, you have parameters at your disposal for describing the hookup to your printer (or printers). You can specify a parallel or serial port address and whether the print server should use BIOS calls to send print jobs to the printer. These options are good for use with laser printers that have custom interface cards, such as the various PostScript-emulation systems for LaserJet Series II printers. *Printer Assist* makes it possible to share most printers on a network.

TWO MODES

Printer Assist can operate in either dedicated or nondedicated mode. In our tests, the nondedicated mode actually proved to be a bit faster in the Time to Print test, but the two modes were about equal in the Time to Send measurements.

We did have some trouble getting the program started. There were errors in the installation program that prevented the program from copying the files from the distribution disk correctly (we also noticed some sloppy typographical errors on certain message screens). Fresh Technology Group's technical support staff was able to walk us through the manual install procedure, however, and we were soon up and running.

Printer Assist is an excellent value. It is worth considering if you need to share printers on workstations but do not need extensive queue-control features. If you use desktop publishing and want to share a laser printer with a special expansion card interface or if you need one product to use

LAN PRINT UTILITIES: SUMMARY OF FEATURES

Products listed in ascending price order

	Printer Assist	Saber Print Manager	Network Assistant Plus	LANSpool	PS-Print	PrintQ LAN	LANsmart/NV
List price	$179 per file server	$195 per file server	$295 per file server	$395 per file server	$395 per file server	$495 for 20-user license	$595 per file server
WORKSTATION							
Uses workstation's expanded memory	❑	❑	■	■	❑	■	❑
Uses DOS commands	■	❑	■	■	❑	■	■
Has menu-driven interface	❑	■	■	■	❑	■	■
Has TSR module	❑	Optional	■	■	Optional	■	■
RAM required for TSR module	N/A*	19K to 48K	29K	4K	12K to 24K	15K to 60K	80K
Hot key	❑	■	■	■	■	■	■
Reassignable	N/A*	■	■	■	■	❑	❑
PRINT SERVER							
Number of printers supported per print server	Limited by hardware	N/A**	1	5	5	4	5
RAM required per printer	4K	N/A**	29K	2.5K	8K	1.5K	None
Has dedicated mode	■	N/A**	❑	■	❑	■	❑
Uses workstation's expanded memory	❑	N/A**	■	❑	❑	❑	❑
Uses DOS commands	■	N/A**	■	❑	❑	■	■
Has menu-driven interface	■	N/A**	■	■	■	■	■
Has TSR module	❑	N/A**	■	❑	■	■	■
Hot key	❑	N/A**	■	❑	■	■	■
Reassignable	N/A*	N/A**	■	N/A*	■	❑	❑
SECURITY							
Password access to shared printer	■	❑	❑	■	❑	■	■
Password access to queue control	■	❑	❑	■	❑	■	❑
QUEUE MANAGEMENT							
Number of priority levels	None †	None	None	None	5 per printer	9	3
Start/stop	■	❑	■	❑	■	■	■
Resends a job	■	❑	❑	❑	■	■	■
Reprints single page	■	❑	❑	❑	■	■	❑
Banner control	❑ †	■	❑	■	■	■	■
Forms control	❑ †	■	■	■	■	■	❑
Print job can be controlled from workstation	■	■	■	■	■ (via *NetWare*)	■	■
Print job can be controlled from print server	❑	N/A**	■	■	■	■	■
Print job can be controlled from file server	❑	■ (via *NetWare*)	❑	■	■ (via *NetWare*)	■	❑
Notifies user of completed job	❑	❑	❑	■	■	■	❑

—Editor's Choice ■—Yes ❑—No
N/A*—Not applicable: the product does not have this feature.
N/A**—Not applicable: *Saber Print Manager* does not use a print server but only enhances *NetWare*'s standard shared-printer features.
† Additional features are available through a separate product called *Q Assist* (not reviewed here).

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Many PC users know there are nuggets of memory sitting unused in most PCs. But those little pieces of memory can add up to 130K!

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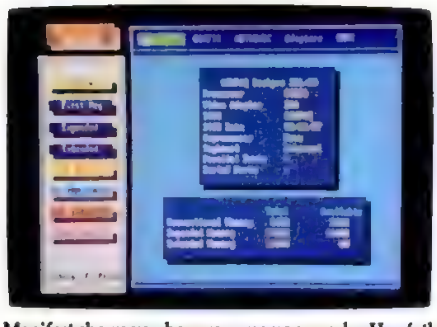
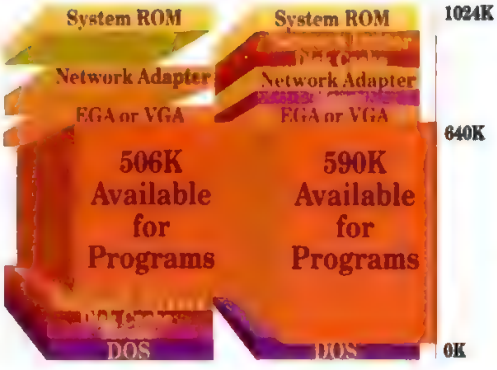
It locates unused (or underused) memory and suggests where you could load networks, buffers, mouse drivers, TSRs and other utilities to increase performance. It even analyzes what type and amount of RAM you have available, and which portions of your memory are faster.



Manifest shows you how your memory works. Here's the first megabyte of RAM, showing unused areas.



Your current memory is full of holes. Our tools can fill blocks of unused addresses between 640K and 1024K to free up memory your programs can use.

Manifest shows you the contents of AUTOEXEC.BAT and CONFIG.SYS files. That can be a big help when diagnosing problems. Manifest tells you all about your hardware, too —from your cpu type to what boards you have installed. Manifest even tests memory speed. And it runs benchmark tests on expanded memory boards so you can make informed buying decisions.

Administering a number of PCs? Manifest's diagnostic and reporting capabilities reduce technical support time. It not only identifies problems but helps to solve them.

You won't need a PhD to understand what you're doing. Manifest has an interactive 'manual' that tells you how to use the program and what benefits you'll get.

And unlike a lot of hot new software, Manifest works on virtually any PC: 8088, 8086, 80286 or 80386. It's a productivity breakthrough from the memory experts at Quarterdeck.

PC WORLD BEST IN ITS CLASS Dec. 18, 1989

Introducing QRAM—the Quarterdeck memory optimizer

End RAM cram in your 8088, 8086 or 80286 PC once and for all. QRAM (pronounced cram), is a package of utilities that gives you unprecedented control over memory, letting you set up your memory the way it will work best for you.

If you have EMS 4.0 or EEMS boards, QRAM can find unused addresses and 'map' memory to those addresses. Then it looks at your AUTOEXEC.BAT and CONFIG.SYS files and figures out what TSRs, network and mouse drivers and DOS resources can be loaded high and where.

And, like all Quarterdeck memory products, QRAM is compatible with the Microsoft XMS specification used by Windows 286, V. 2.x.

If your PC has 'shadow RAM,' there's even more gold in your PC. QRAM finds the unused parts and puts them under your control.

QRAM optimizes your memory performance by moving utilities and drivers out of the area between 0K and 640K — freeing it up for your programs to use.

And if you have an EGA or VGA-equipped PC and don't need graphics at the moment, QRAM will make an additional 96K 'nugget' of memory available! When you need graphics again, QRAM will switch you back to graphics mode! Think how helpful that will be for those big dBASE files.

It can't work miracles, but if there's memory available anywhere, QRAM lets you use it to increase your PCs speed and performance.

QRAM is available bundled with Manifest for just a few dollars more than Manifest alone.

Manifest and QRAM—two more examples of Quarterdeck's commitment to mining the most productivity out of the PC and software you own today.

in your PC.
tools can mine it for you.

Introducing QEMM 50/60 Version5.0

QEMM (Quarterdeck Expanded Memory Manager) 50/60 is the gold standard in memory management for the IBM PS/2™ series 50 and 60. It works with IBM's Memory Expansion Option, Expanded Memory Adapter/A and compatible memory boards.

It supports all three specifications for expanded memory: EMS 4.0, EMS 3.2 and EEMS memory so you can run all expanded memory programs.

And it also works with Microsoft's XMS specification, in case you want to use Windows.

QEMM lets you use memory locations between 640K and 1024K to run TSRs, mouse and network drivers, DOS resources and MCA adaptors. That means you can gain up to 130K of memory space below 640K for your programs.

Best of all, QEMM is designed to be easy to use—even for those new to the PC. Just install it and type 'optimize,' and it looks at your AUTOEXEC.BAT and CONFIG.SYS files and loads whatever it can in high memory. Automatically.

QEMM 50/60 is priced economically. It's the biggest boost you can give your PS/2 for under $100.

QEMM and DESQview let you multitask and window with the programs you know and use today.

Introducing QEMM 386 Version5.0

QEMM 386 can expand the memory of all 386-based computers, including PCs with 80386 upgrade boards. It makes your memory compatible with EMS 4.0, EMS 3.2 and EEMS memory without having to add special hardware. It's compatible with protected-mode programs (like 1-2-3 Release 3, IBM Interleaf and Paradox 386) using DOS extenders compatible with the Quarterdeck/Pharlap VCPI spec.

QEMM also works with Microsoft's XMS spec to extend memory for Windows users.

QEMM gives you maximum control over your memory between 640K-1024K. It can find unused memory nuggets as small as 4K and use them to free up room for programs to use.

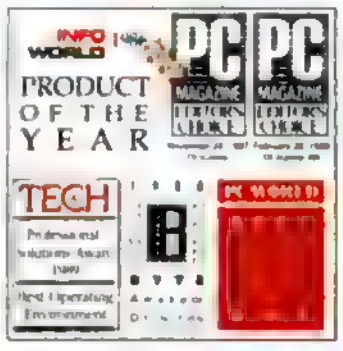
QEMM 386 even monitors how your programs use memory while they're running. Then it shows you where there's additional memory you can use. It even measures which parts of your memory are fastest and 'decides' how to use them for better performance. In action, it's easy and fun—almost like having an *artificial intelligence* program to help tune up your PC.

All these capabilities add up to greater performance at a very low cost. And QEMM lets you go for the gold without having to become an expert on the PC memory puzzle.

Like all Quarterdeck products, it works with your current PC and favorite software.

A few words about DESQview

What's the smartest thing to do with all that additional memory? Run DESQview and multitask your favorite programs in windows. Use a mouse or keyboard and you can run graphic and text-based programs side-by-side. All without having to invest in a bigger hard disk or more memory.



DESQview's recent awards.

From Manifest to QRAM, QEMM and DESQview, Quarterdeck helps you mine the most from the software and PC you have today.

System Requirements

Manifest: 8088, 8086, 80286 80386 and i486 PCs & PS/2s

QRAM: 8088, 8086, 80286 PCs. Use of high memory is only available when PC has EMS 4 or EEMS expanded memory or Chips & Technologies shadow RAM.

QEMM 50/60: 80286-based PS/2s and compatibles with IBM PS/2 80286 Memory Expansion Option, IBM PS/2 80286 Expanded Memory Adapter/A or compatible.

QEMM-386: 80386-based PCs and PS/2s and PCs with 80386 add-in boards.

Trademarks: IBM, PS/2: IBM Corporation; PC Tools: Central Point Software; 80386, i486: Intel Corporation; Chips and Technologies: Chips and Technologies

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	QRAM and Manifest 1.0			$79.95	
	QEMM 50/60 5.0 (with Manifest*)			$99.95	
	QEMM 386 5.0 (with Manifest*)			$99.95	
	Shipping & Handling $5 in USA/ $10 outside USA				
	California Residents add 6.5%				
	Grand Total				

*Introductory offer extended to 6/30/90

CIRCLE 338 ON READER SERVICE CARD

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with different *NetWare* versions, put *Printer Assist* on your list. Fresh Technology Group intends to release a new version of the program this spring, with a reduction of its shared-printer memory requirements from 4K to 3K and with improved performance.

PrintQ LAN

If there is such a thing as industrial-strength printer sharing on a network, then *PrintQ LAN* from Software Directions provides it. This is the only product we tested that is priced on a per-user basis, and the $495 list price for a 20-user license makes it the most expensive product in the group for LANs with more than 20 users on one file server.

If you're running many networks or one large one, a relatively expensive program may be the best choice if cheaper ones can't do what you need. In many instances, *PrintQ LAN* has features that the others do not offer.

PrintQ LAN does not rely on the *NetWare* PRINTCON database for its printer sharing. This means that the same program can be used on older networks, from Version 2.0a right up through *NetWare 386*. It will also run on any NetBIOS network. *PrintQ LAN* was designed to furnish mainframe-style print services.

The program offers many of the features you would expect: a hotkey to pop up menus on a workstation to control jobs sent to the print server, extensive queue controls for a print server running in nondedicated mode, named queues, banner control, and more.

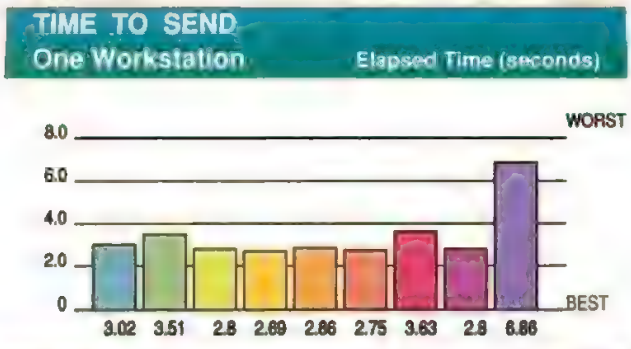
BEYOND THE BASICS

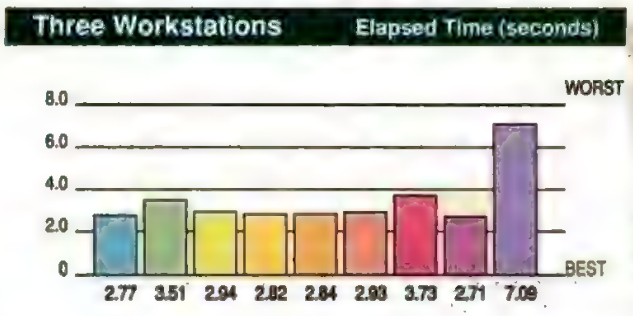
PrintQ LAN goes far beyond the basics, however. There are extensive facilities for printer setup control, so that you can send Esc-command sequences to a shared printer. There are many options that support the use of forms on shared printers, including the ability to restart a print job from any specific page instead of from the beginning—essential if you have a printer jam in the middle of a long run of invoices. You can also configure the program to work with nonstandard printer interfaces, such as those used by add-on boards for laser printers.

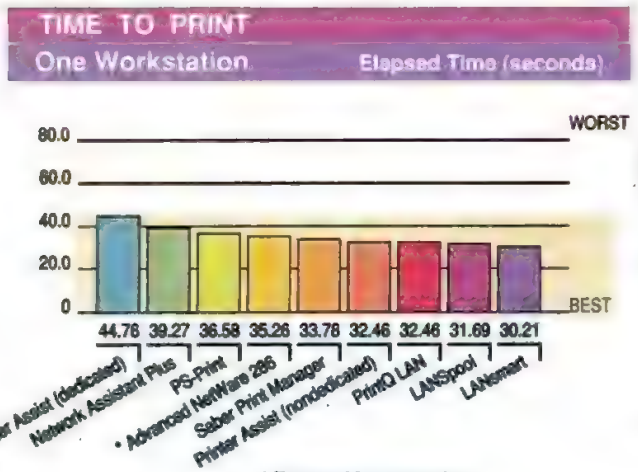
PrintQ LAN even requires fewer forms changes in a shared printer; if there are a number of equal-priority queued jobs that require various forms to be loaded, *PrintQ LAN* will find all the jobs that can use the currently loaded form and process them first (regardless of the order in which they

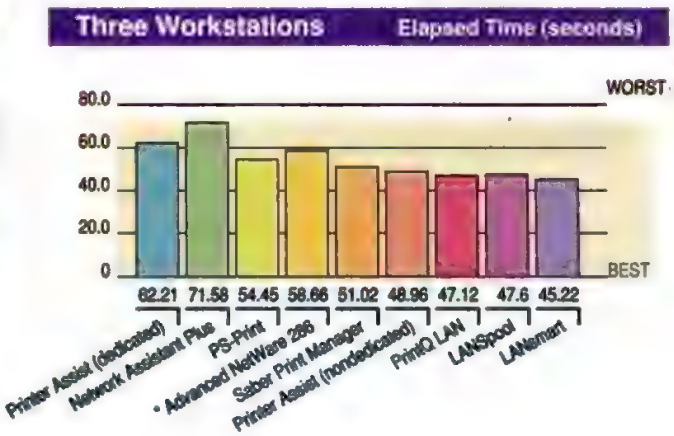
PC LABS — PERFORMANCE TESTS: LAN PRINT UTILITIES

Speed is important when it comes to printing, especially on a network with shared printers. But our tests show that most print utilities perform similarly, with only a few lagging close behind.





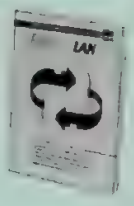




* Reported for comparison.

FACT FILE

EDITOR'S CHOICE



***PrintQ LAN*, Version .96**
Software Directions Inc., 1572 Sussex Turnpike, Randolph, NJ 07869, (800) 346-7638, (201) 584-8466
List Price: With 20-user license, $495, with 100-user license, $1,295, each additional 100 users, $495.
Requires: Novell *NetWare* 2.0a or later; on each workstation, 60K RAM (15K with EMS); DOS 3.0 or later.
In Short: *PrintQ LAN* is remarkable for its strength and flexibility. It's best suited for power users who want access to a wide range of print-service features and for developers who want to incorporate complex printer sharing into custom applications for large organizations.

CIRCLE 423 ON READER SERVICE CARD

were submitted), before starting another job that requires a different form. That kind of intelligence is a big plus.

Even the queues themselves have some flexible intelligent features. You can use the same queue name for multiple printers. *PrintQ LAN* will then send your print job to any available printer with a matching name. This means that you could have a bank of three printers hooked up to the same print server, and users would be able to access any of the three with the same queue name. Without this feature, all users might select the same printer, resulting in slower printouts and inefficient use of the available printers.

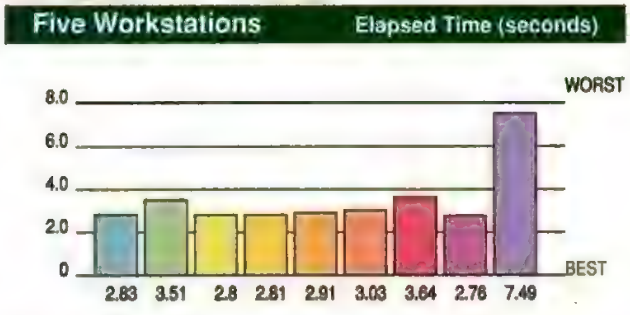
DEVELOPER'S DREAM

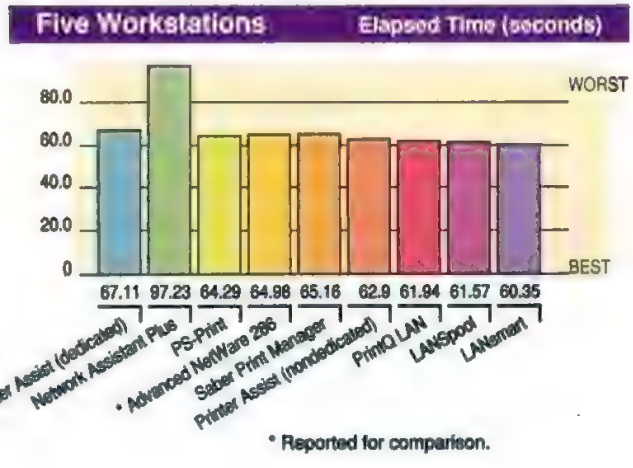
The real strength of *PrintQ LAN* is its flexibility. You can configure it to control the options presented to users. Software Directions can supply free source code to developers who want to build *PrintQ LAN* features into their applications. This availability is of special interest to large organizations that run complex custom applications, since it provides access to powerful print-service management without compelling you to create it from scratch.

PrintQ LAN is a little more expensive than the others, but if you need the extra strength it is worth the investment. To encourage users of competing products to upgrade to *PrintQ LAN*, Software Directions offers a $295 trade-in credit, which goes a long way toward leveling some of the cost differential. *PrintQ LAN* may be overkill for a small office that simply wants to share a printer among a few workstations, but for large organizations and complex network schemes, it is a very attractive package.

For the **Time to Send** test, we measured the amount of time it took to transmit the print job at each station, and we averaged the results for all workstations in the test. Timing started when the test program started to send the print stream to the printer port and stopped when control returned to the program.

For the **Time to Print** test, we measured the time it took for the completed print job from each station to come out of the shared laser printer, and we averaged the results for all workstations in the test. Timing started when the test program started to send the print stream to the printer port and stopped when the second page of the print job dropped from the printer.





* Reported for comparison.

HOW WE TESTED

PC Labs tested seven print utilities for Novell's *NetWare* using a self-timing performance test. This program loaded a two-page document (approximately 3,100 bytes) into a workstation's system memory, a step that was designed to eliminate possible delays in reading the data off the file server and to avoid variations in disk access speed among workstations. By specifying a simultaneous start time for all workstations in the test, we were able to guarantee maximum contention for network resources.

The network server was an IBM PS/2 Model 80 running *Advanced NetWare 286* over Ethernet. There were six IBM PC ATs attached, all operating at 8 MHz. These machines had 512K memory and used a variety of display adapters and monitors. Five of the stations were used as workstations, while the sixth was used as a print server for the programs that made use of one. A Hewlett-Packard LaserJet Plus was used as the shared printer and was connected to either the file server or the print server using a parallel connector.

Tests were run with all workstations logged onto the network, and with the *NetWare* MONITOR screen active on the file server console. Each program was tested using one, two, three, four, and five workstations at a time, and we are reporting the results for one, three, and five workstations. *Printer Assist* was tested in both nondedicated and dedicated print server modes. All programs that ran nondedicated print server modes were tested with the printer server idle. For comparison, *Advanced NetWare 286* was also tested with the shared printer attached to the file server.

CONTINUES

PS-Print

Brightwork Development is well known among LAN administrators as a publisher of many different utilities that make it easier to use and manage a Novell network. *PS-Print* is the company's print-server product, and the $395 program is a middle-of-the-road choice in its field.

Like many of the other products tested here, *PS-Print* relies on the PRINTCON database that is part of *NetWare*. This means that it cannot be used with *NetWare* versions prior to 2.1*x* but will work with *NetWare 386*. *PS-Print* queues are named in the same manner as *NetWare* queues, and all the standard *NetWare* print-service programs can be used with them. Thus, you can continue to use the Novell CAPTURE and ENDCAP commands and still gain access to the benefits of a shared printer on a workstation.

PS-Print also includes a TSR utility that can pop up over applications that are already running. You can select different choices from the screen, such as specifying a print queue or ending a print job.

The program is fairly easy to install and configure, and there is an installation batch file that automates many of the steps. The manual explains the various steps clearly, but using more screen shots to illustrate the procedures described in the text would be an improvement. A companion program, *QueueIT!*, is bundled with *PS-Print* and makes more-liberal use of screen images in its documentation.

In PC Labs testing, *PS-Print* was just slightly slower than the top performers on the Time to Print tests, and was among the fastest programs on the Time to Send measurements.

The program has a few unique features. For example, it can rewind a spooled job for reprinting if necessary, and it offers a great deal of control since you can rewind line by line or to a specific character if you wish. This can be handy when you encounter a jammed printer in the middle of a long print job. The memory-resident programs are called with a Ctrl-Alt key combination, but you can reconfigure these if you prefer some other combination.

PS-Print requires up to 24K RAM on

COMPOSITE VIEW: LAN PRINT UTILITIES

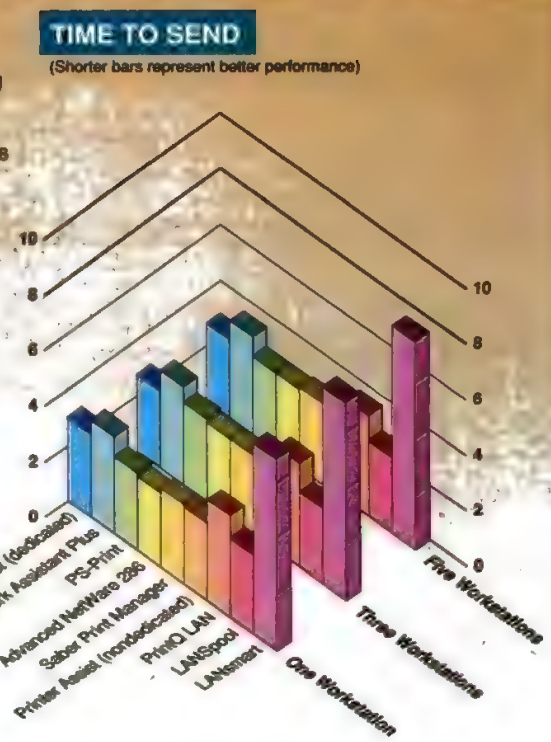
PC LABS

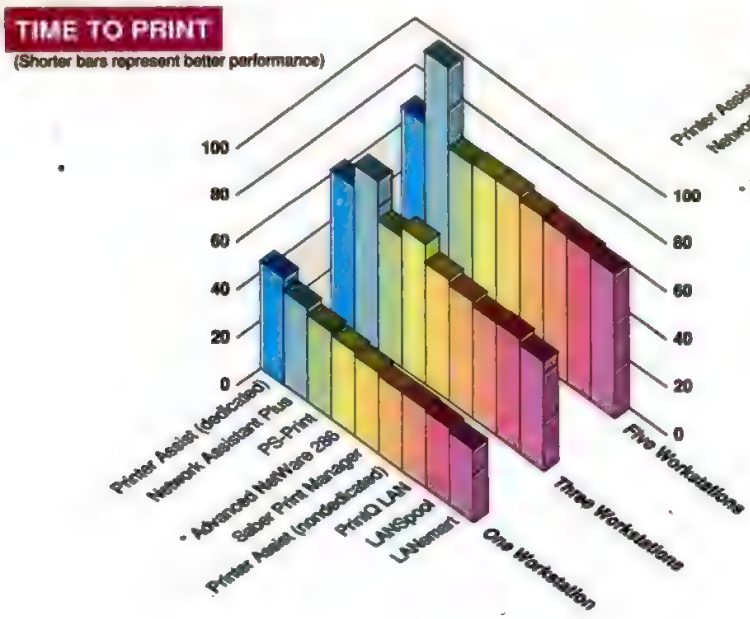
The most interesting overall result is the similar performance of all these programs, especially when you consider that there are significant differences among the packages.

On the **Time to Send** test, using one workstation, six of the nine scores were consistently within 0.35 seconds of each other. Only one product, *LANSmart*, was significantly slower than the others and might possibly produce a noticeable difference in actual performance.

The results for the **Time to Print** test were similar. *LANSmart* was marginally faster than the rest of the field, but *LANSpool*, *PrintQ LAN*, and *Printer Assist* (in nondedicated mode) were within a handful of percentage points of each other in terms of speed. Only *Network Assistant Plus* showed distinctly slower times, with its average time curve sloping upward more rapidly than the others as the number of workstations increased.

Thus, there is no clear winner here in terms of speed since the best times are shared by a cluster of programs. You should base your selection on whether a given program has the features you require for your LAN.





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FACT FILE

***PS-Print*, Version 3.0**
Brightwork Development Inc., 766 Shrewsbury Ave., Building 2, Tinton Falls, NJ 07724; (800) 552-9876, (201) 530-0440.
List Price: $395 per server.
Requires: Novell *NetWare* 2.10 or later; up to 24K RAM on each workstation, 8K RAM on each print server; DOS 3.1 or later.
In Short: *PS-Print* offers middle-of-the-road features and price, making it a reasonable value that is appropriate for *NetWare* installations where the main objective is to add print-server facilities to existing shared-printer services.

CIRCLE 424 ON READER SERVICE CARD

each workstation, and about 8K per shared printer on the print server. With a moderate price, average memory requirements, typical performance times, and close ties to the native *NetWare* print facilities, *PS-Print* is a reasonable option if you want to add print-server support to a *NetWare* network.

Saber Print Manager

Some of the utilities evaluated here do almost anything, but *Saber Print Manager* is different; all that this $195 product does is facilitate the submission of print jobs to a printer on the network server.

This is the only program that doesn't support shared printers at the workstation, but we evaluated it because it helps you share printers on a Novell network.

The program builds upon *NetWare*'s services, starting with those found in Version 2.0a. There are actually two separate programs on the distribution disk. One is NETPRINT, an older product designed for *NetWare* 2.0*x;* the documentation for this version is included in a disk file. The printed manual covers *Saber Print Manager*, which is designed to take advantage of the new print services offered by *NetWare* 2.1*x*.

There are three different versions of the program on the disk. One contains all the features and requires about 48K of system memory on a workstation. The other two versions offer a condensed feature set, which omits help screens and print-job management, so that the memory require-

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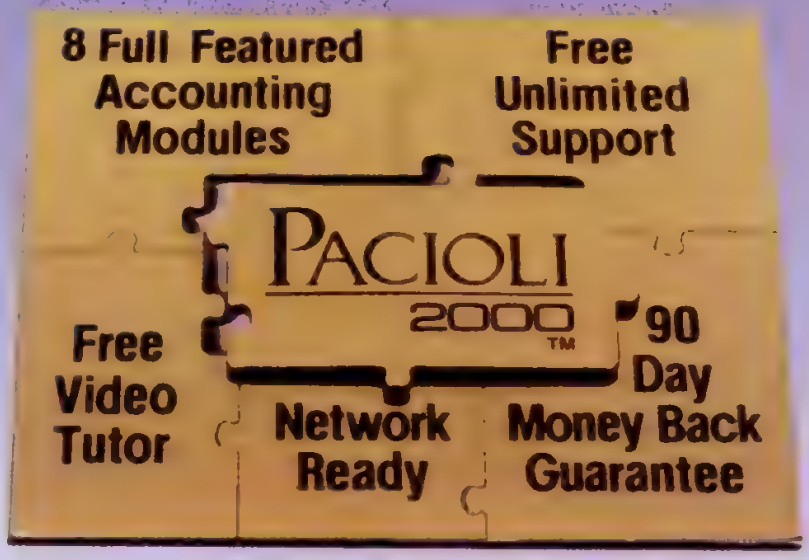

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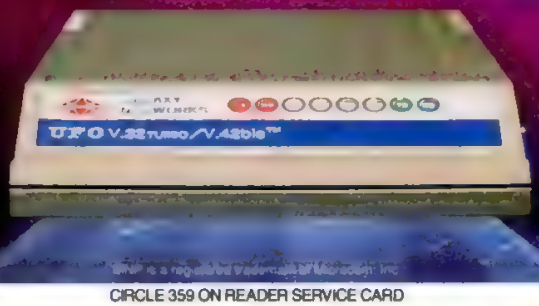

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ment can be reduced to as little as 19K.

Saber Print Manager takes advantage of *NetWare*'s shared-printer features. Through pop-up menus you can select a named print queue, start and end a shared print job, and even send printer-configuration commands. Users who find Novell's systems difficult to use may find this a simpler solution. Network administrators can also create their own help screens to provide custom support.

CONFUSING INSTALLATION

Saber Print Manager was a little confusing to install. The manual tells you to copy the files into a shared directory on the server, while the disk label instructs you to run an INSTALL program. There is also a READ.ME file on the distribution disk that lists the disk's contents, among other details. This file lists two programs that are supposedly included on the disk,

FACT FILE

***Saber Print Manager*, Version 2.0**
Saber Software, P.O. Box 9088, Dallas, TX 75209; (800) 338-8754, (214) 361-8086.
List Price: $195 per server.
Requires: Novell *NetWare* 2.0a or later (not including *NetWare 386*), 19K to 48K RAM on each workstation, DOS 2.1 or later.
In Short: *Saber Print Manager* is a low-cost utility designed to make it easier to access *NetWare*'s print services. It does not provide print-server facilities, but if you are looking to simplify the use of a printer attached to your file server, this is an appropriate alternative.

CIRCLE 425 ON READER SERVICE CARD

SETUP.EXE and RESET.EXE, but they simply weren't there. The missing programs are not significant, but the conflicting documentation and READ.ME file errors are disconcerting.

Once the program was installed and configured, it was a snap to run. It was easy to assign jobs to different queues and pop up the menu over applications.

If your server is located across the hall or down a flight of stairs, *Saber Print Manager* is not going to be much help. If you have a small network where the file server can be easily reached by all who need to share a printer, however, the program's low cost and ease of use make it an appropriate tool and an attractive value. ■

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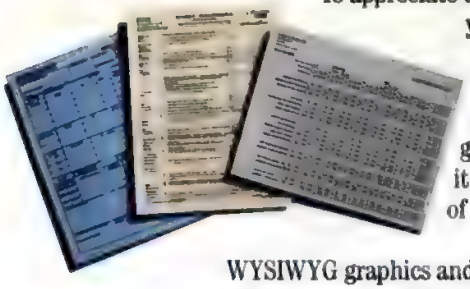

To appreciate the benefits of JetForm™ software, we invite you to first examine the subject of business forms themselves. And why every business has so many.

It's because forms are the proven way to gather information. Communicate it. Store it, and process it. Which is precisely the point of view from which JetForm was developed.

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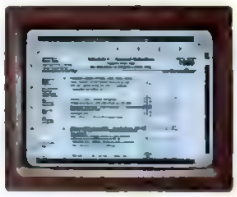

But we also give you something else. And that's a set of capabilities that turns forms software from a handy way to replace pre-printed forms into a powerful way to run a business.

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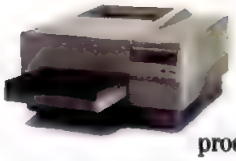

As years pass, other software makers may discover the true purpose of business forms, and upgrade their products to the capabilities of JetForm. But JetForm has them today. And a new business day starts tomorrow.

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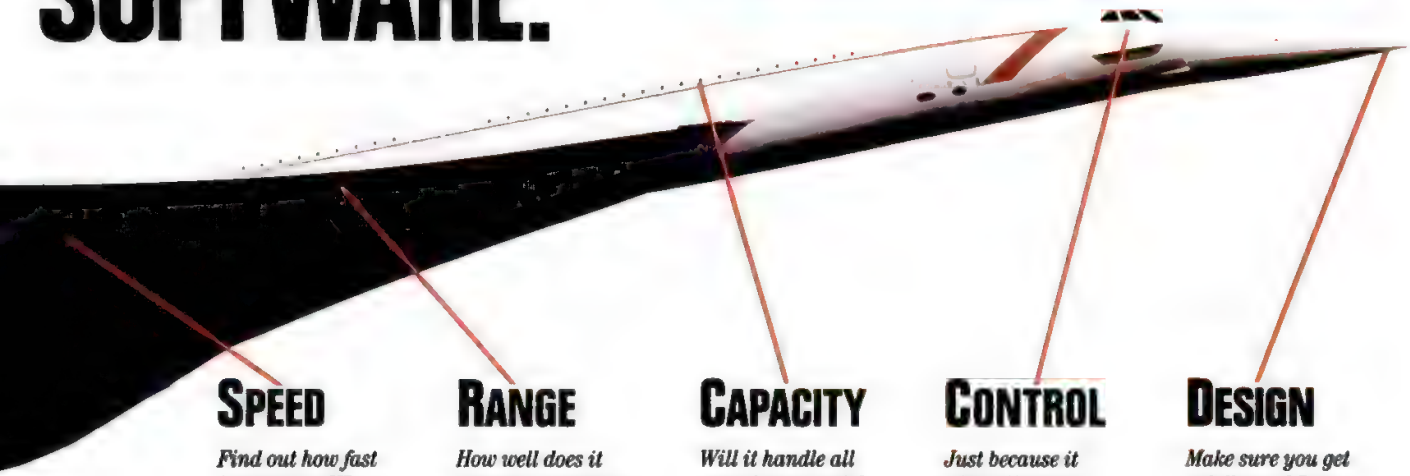

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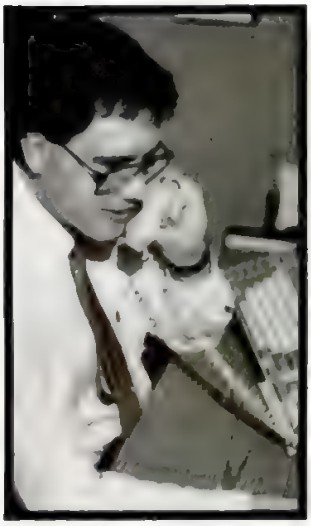

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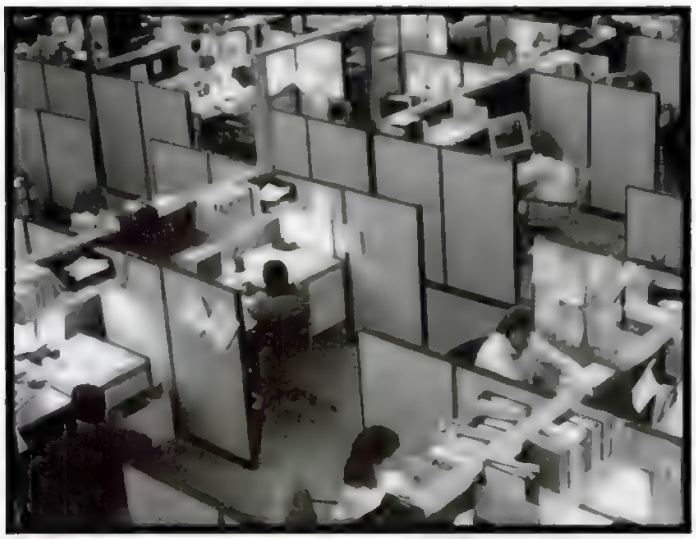

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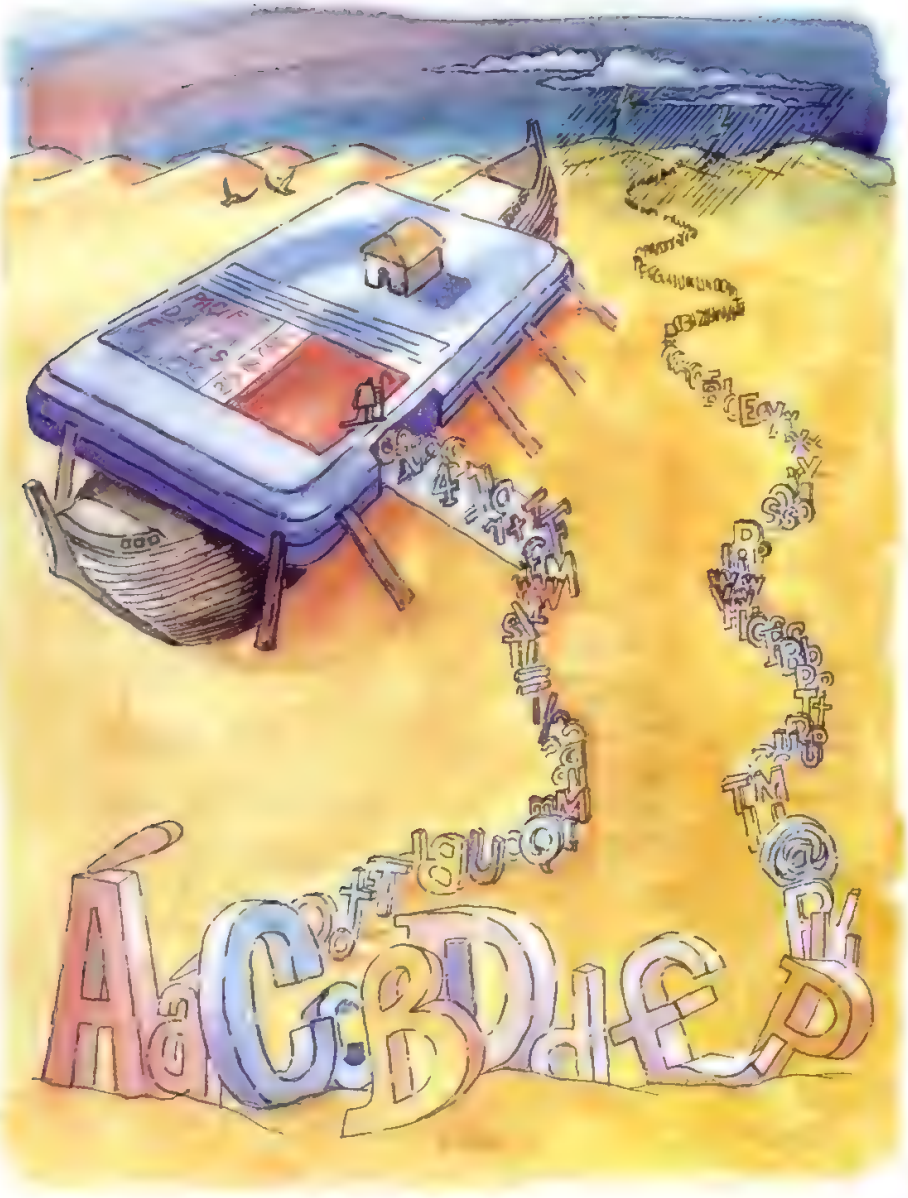

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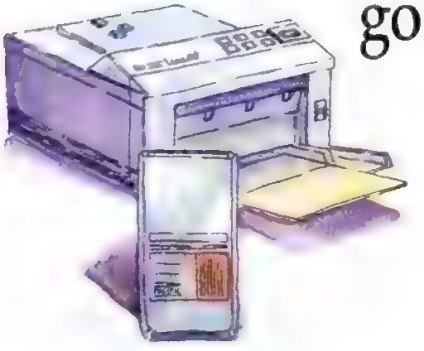

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THE NEXT WAVE:

LANs Without Wires

If you're concerned about your office getting tangled up in cabling problems for months when you install your network, new radio and infrared technologies offer an intriguing alternative to the woes of wiring.

BY FRANK J. DERFLER, JR.

Network wiring won't always go where you want it to go. If your company expands into the building across the street or moves into temporary quarters, you'll need to link the new office's PCs as promptly and painlessly as possible. And if you plan to dismantle the temporary site in a few months, all the headaches and costs of wiring it up won't be worth the potential benefits.

Or maybe some of your tech staff moves around the company to hard-to-access locations. They have to stay on the network wherever they go—but how do you keep them connected?

The answer to these problems is wireless networking, either to replace or to augment wire-based LANs.

Wireless LAN systems use one of three transmission techniques: UHF radio, some type of light beam, or carrier-current radio, which sends signals through AC power lines. Of the five wireless LAN packages we review in this roundup, two rely on UHF radio to send their data, one makes use of infrared light beams to do the job, and two employ a novel method of sending data through your building's AC power lines to your networked PCs.

UHF radio systems, such as LAWN and ARLAN 450 (both reviewed here), operate near the same frequencies as cellular telephones—slightly over 900 MHz. They usually cover a frequency spread of 20 or more megahertz, which qualifies them as spread-spectrum systems. Spreading the signals over a wide bandwidth reduces their susceptibility to many noise sources that are found in commercial buildings. And equally important, spread-spectrum technology improves security—even beyond that of conventional wired LANs—since no single frequency can be

THE LAN SURVIVAL GUIDE

tapped to siphon off data.

Light-wave systems, like the Photolink package we tested, typically operate in the infrared spectrum; the beams of light they produce are invisible to the human eye. Interestingly, the systems don't have to be within view of each other to communicate. They can work by reflecting light beams off some common point like a distant ceiling or wall. The wide bandwidths of light-wave systems and some radio systems allow signaling at a rate of several hundred kilobits per second (kbps).

Carrier current radio systems such as POWERNet and CarrierNET fall into a different category. They send low-frequency radio signals over AC power lines, so they aren't "wireless" in the strictest sense. At about $200 per node, they are less expensive than UHF and light-wave transceivers, but their narrow bandwidth and RS-232 cabling limit their signaling rate to a maximum of 115.2 kbps.

DIFFICULTÉS À PARADIS

Beware: for all the physical flexibility they offer, wireless LANs suffer from a number of drawbacks inherent to sending network data over anything other than dedicated lines. For example, systems such as CarrierNET that use serial ports usually limit throughput to 9,600 bits per second or less. Faster transmission is too much for serial ports to handle, so you'll have to use some type of internal adapter to route the input/output data stream between the PC and the transceiver (transmitter/receiver).

Radio and infrared technologies are both limited by range and environment. Radio-based systems' signals can travel about a quarter of a mile outdoors and 200 or 300 feet indoors. With infrared light beams, the range is limited to the line of sight between one station and another station or a reflector. And, outdoor transmission for either technology can be adversely affected by weather conditions.

Although radio systems like LAWN and ARLAN 450 use the spread spectrum to minimize interference, other radio sources can disrupt their communications. In one particularly mysterious case, our PC LAN Labs crew was stumped by LAWN's miserable performance. We spent several days looking at such factors as different versions of the ROM BIOS, bad transceivers, and even the presence of nearby military radar installations. As it turned out, the problem wasn't the LAWN system; the motion sensors in PC LAN Labs' burglar alarm (which emit and sense reflected radio waves) blanketed out the LAWN signals.

Radio-based systems can transmit about a quarter of a mile outdoors and 200 or 300 feet indoors. With infrared light beams, the range is limited to the line of sight between one station and another station or a reflector.

To test the theory, we jimmied the alarm panel and disconnected the motion detector on a Saturday night. This sent a silent alarm to the security company and resulted in a visit to the LAN Labs from several representatives of the local sheriff's

RADIO LANS: Threat or Menace?

by Bill Machrone

As the guy who usually beats the drum loudest for new technology, I feel strange sounding a cautionary note here. A radio-frequency (RF) LAN solves a variety of problems, mostly having to do with installation and ease of use. It uses very high technology, including spread-spectrum transmission, a technique favored by the military for its security and freedom from interference.

My biggest objection is that it's a radio device. Computer manufacturers are spending millions under intense scrutiny from the FCC lest their machines emit a stray microwatt of RF energy. Yet the RF LAN vendors propose that we plunk an antenna on top of the machine and pump out tens of thousands of times more power into an environment already reeling with unnecessary electronic emissions. The FCC doesn't mind because radio devices are *supposed* to emit, while PCs aren't.

With mounting concern about emissions in almost every part of the radio spectrum, who's to say what is safe? Workers, manufacturers, and researchers are still debating safe levels for electromagnetic fields emanating from monitors, and these levels are far lower than those associated with with radio LANs (see "Unwanted Emissions: EMI and RMI," *PC Magazine*, October 31, 1989, page 140). Indeed, the only reasons that I haven't invested in a portable cellular phone are the doubts I feel about having the antenna a few inches from my head.

Security and freedom from interference are shaky propositions at best. Your competitor can simply move in next door, buy the same brand of RF LAN you own, and tune in on your business. For that matter, your enterprising, technologically oriented employees can conceivably browse the activities of other servers and other departments in their spare time. And who's to know what will cause interference? The original Sputnik set off garage door openers as it swept overhead. NORAD's radar once interpreted the rising moon as an enemy missile launch. The speakerphone on my desk receives conversations from gypsy cabs out on Park Avenue.

It irks me that manufacturers are overlooking a viable solution: infrared. Of the five wireless systems in this roundup, only Photolink takes advantage of this technology. Light-emitting diodes and sensors are cheap and capable of high data rates; everyone agrees they have no deleterious effects on the environment or its inhabitants. The only problem is that light doesn't go around corners or through walls. Never mind—engineers thrive on adversity. It's easy to imagine a variety of repeaters, light pipes, corner reflectors, and other devices on door frames and atop cubicle walls.

Let's hope that the RF LAN branch of technology withers before it takes valuable light from less questionable endeavors. ■

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office. LAWN worked, but we had some explaining to do.

UHF and infrared technologies have another drawback in common: relatively high cost. These are complex technologies, and parts for each UHF radio- or light-wave transceiver are pricey. LAWN, a UHF wireless network, costs $499 per transceiver, and that's the least expensive product of its type in our review group. You can typically install Novell's *Advanced NetWare 286* with ARCnet or Ethernet adapters for about the same money and get more capability and throughput—but only if you'll run the cables.

For those thinking of avoiding broadcast technologies altogether, don't assume that choosing an AC power-line product will eliminate all obstacles. Because low-frequency signals will not go through transformers, all of the LAN stations must be on the same leg of the AC transformer that feeds power to the building. If the transceivers are fed from different transformer windings, some transceivers may be able to interact with transceivers in one part of the building but not in another. There are work-arounds for these problems, but you will need well-trained electricians and special equipment.

AC power-line products may become known for uncovering unsolvable mysteries. During our tests we found some AC power connectors that were inexplicably dead to carrier current radio signals; evidently they are good for nothing more than sending print jobs. Yet another caveat: specialized software drivers and other proprietary components are often necessary when you are interfacing conventional LANs with wireless products. If you intend to set up a mixed LAN, make sure you can get a guarantee from the wireless LAN vendor that the arrangement you have in mind will actually work.

If you still believe that wireless LAN technology is a viable alternative for your company, keep in mind that there is one more wireless option on the market. At least one company—Agilis, of Mountain View, California—has a patented version of spread-spectrum radio technology that is said to permit a rate of 230 kbps. We were unable to test the Agilis product because it is currently available only as part of a line of modular hand-held PC workstations. Agilis promises an ISA bus transceiver and adapter for later this year. The product's current speed is sufficient for e-mail but falls far short of Ethernet's theo-

EDITOR'S CHOICE

- **ARLAN 450**
- **LAWN**

A general endorsement goes to the wireless LAN products that use spread-spectrum radio techniques to transfer data, perform e-mail tasks, and share printers. These systems are more practical and offer better flexibility than AC power-line alternatives and also beat out the optical options in most installations.

Telesystems SLW offers ARLAN 450, whose use of Novell's *NetWare* along with spread-spectrum technology makes it hard to beat. Setting up ARLAN is much like installing normal network cards except that the adapters connect to an antenna instead of to cabling. ARLAN provides excellent capability for many LAN designers—at a steep price.

O'Neill Communications' LAWN also employs spread-spectrum technology, but the transmitters have lower power and the software doesn't possess the capabilities of a full LAN operating system. Among its strong points, it requires virtually no technical expertise to install or operate.

In select installations, the RS-232C and multiport capabilities of Photonics Corp.'s Photolink make it the best choice, but the need for a direct line of sight (or at least a surface to bounce the light off) limits the number of places you can use this product. When it fits, it works beautifully, but it doesn't fit in enough places to earn Editor's Choice status, and it lacks *NetWare* capability.

The choice between ARLAN 450 and LAWN is a choice between high cost with many features and relative economy with less versatility. Either one can be a lifesaver when cables just won't do.

WIRELESS LANs: SUITABILITY TO TASK

Which wireless LAN scheme is best for you? It's not enough for a no-cable LAN to solve your logistical problem; if it won't perform the LAN tasks necessary to your workplace, the fact that its signal reaches to Timbuktu won't help much.

We rated these five systems on their ability to handle four specific LAN tasks: file transfer, printer sharing, electronic mail, and database access. Effective throughput accounts for a large part of this rating, but the ability to work in a background mode can compensate for low speeds. If you can dispatch an electronic mail message or print job and then turn to other work, it generally doesn't matter whether the actual transfer takes 4 seconds or a minute and 4 seconds.

Each task has different characteristics. An exchange of e-mail messages is essentially a server-to-server file transfer with overhead. Sending a print job to a printer involves spooling and queuing the job in addition to moving a file. With a traditional program, a single manipulation of a database requires sending hundreds of blocks of data across the link.

Factors other than speed can add a lot to a system's appeal. The ability to share a printer without having an attached PC is valuable, no matter how long the file transmission takes. And not every product will accomplish its tasks right out of the box. Each product was reviewed in its test configuration, which means that PC LAN Labs may have added an operating system, an interface card, and appropriate e-mail software, as any user would have to do. Consider the total cost of a wireless LAN package before you make a commitment.

0 = Completely unsuited for the task
1 = Poorly suited for the task
2 = Marginal for the task
3 = Good for the task
4 = Excellent for the task

Product Name	SUITABILITY TO TASK
File transfer	■
Printer sharing	■■
E-mail	■■■
Database access	■■■■

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The 8900 Series can print six- to nine-part forms at up to 400 characters per second, data processing applications at up to 600 cps, or correspondence at 100 cps in the letter quality mode. That kind of flexibility — not offered by many other printer manufacturers — makes the 8900 Series a natural for applications of all types.

What's more, these printers offer rugged reliability. Meantime between electronics failures is 9,000 hours with no duty cycle limitations. The 8900 Series can even replace some low-end line printers with its 16,000 pages* a month output capability.

Intelligent printing means easy printing.

What also sets 8900 series printers apart is their combination of intelligent forms handling with flexible printing and paper handling capabilities. For example, TI's special Z-Axis Control™ automatically senses a document's thickness and adjusts the printhead to its optimal position.

The Page Finder™ feature helps eliminate misaligned paper by automatically sensing the right and left margins, regardless of where the tractors are set or where the document is inserted. Plus, 8900 Series printers can automatically sense the top of forms to achieve zero tear-off. As a result, users don't have to worry about making adjustments themselves.

The 8900 Series also features a user-friendly control panel with a liquid crystal display. Users can select options like print quality, font styles, menu status and others with the touch of a Powerkey™ button.

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An 18-pin printhead ensures crisp, readable text, even on the last copy of up to nine-part forms. With five print speeds, the printers can handle high-speed reports as well as letter-quality correspondence.

Seven-color printing is also available. Some models offer a paper parking feature that enables users to feed a single form or other cut-sheet paper without having to disconnect the tractor feed. And you can deliver extra value by customizing the printers to meet your customers' unique needs.

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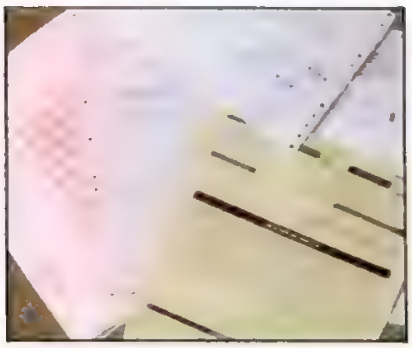

TI's 8900 Series prints a variety of forms for a variety of users.

For single-user printing, offer TI's new 83X Series.

TI also provides you with a workstation printer solution. The Model 830 and 835 printers combine such personal printer features as an easy-to-use control panel and key forms printing features like short tear-off and a straight paper path.

The Model 830 is a narrow carriage printer while the 835 has a wide carriage. Both printers feature such versatile paper handling characteristics as bottom, rear and top feed; automatic cut-sheet insertion; paper parking; and up to five-part forms printing.

You can also offer options like a user-installable serial interface board; a sheet feeder; and a pull tractor (required for bottom-feed paper handling).

Users can choose from three print speeds, including high-speed draft mode (300 cps), utility mode (250 cps) and near-letter quality mode (63 cps). Whether your customers need the multi-user 8900 Series or the single-user 83X Series, TI lets you offer the printers they need when their needs are demanding.

TEXAS INSTRUMENTS

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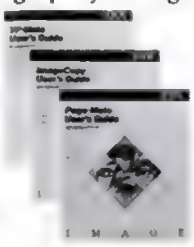

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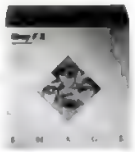

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CIRCLE 200 ON READER SERVICE CARD

retical limit of 10 megabits per second. The upshot? For heavy-duty LAN operations, you still need wires.

Switching your system to a wireless LAN may simply mean you've exchanged cable problems for other headaches. Some UHF and light-wave systems are able to carry the load of real workgroups. Others are limited to low-speed signaling rates and can't provide the file-sharing capabilities of media-shared networks.

Nevertheless, two products, Photolink and ARLAN 450, allow full LAN capabilities. They let you take a shared resource such as a server's hard disk and treat it as a "virtual drive," making it appear as a DOS drive letter on your desktop PC. O'Neill Communications' LAWN, Photonics Corp.'s Photolink, and Telesystems SLW's ARLAN 450 have unique features that will appeal to different buyers. If you can't install cables to make your network go, one of these products will probably solve your no-cable dilemma.

CARRIER CURRENT TECHNOLOGIES INC.

CarrierNET

by Kimberly Maxwell

Wouldn't it be nice if you could plug your PC into any AC outlet to transfer files and share printers? That is the promise you get from Carrier Current Technologies. Carrier Current manufactures a lightweight $199 box called CarrierNET that you connect to your PC and plug into the wall outlet. Equipped with the proper software, CarrierNET can exchange files with other PCs and submit print jobs to standalone printers through AC power lines.

FACT FILE

CarrierNET
Carrier Current Technologies Inc., 9600-J Southern Pine Blvd., Charlotte, NC 28217; (800) 222-0377
List Price: CarrierNET, $199; *ExcellNET*, $79; CarrierNET Plus $399.
Requires: 256K RAM and RS-232 serial port for each PC DOS 2.0 or later.
In Short: This network hardware/software product uses existing power lines to let networked PCs share printers, exchange files, and send or receive electronic mail. Easy installation and convenience make CarrierNET a good wireless option, particularly for sending jobs to a remote printer.

CIRCLE 549 ON READER SERVICE CARD

The basic CarrierNET package includes only peripheral-sharing utilities. For another $79, Carrier Current will sell you Excelltech's *ExcellNET* software so you can transfer files and send or receive electronic mail. And a $399 Carrier Current product called CarrierNET Plus allows you to position a printer anywhere in your office without having to connect it directly to a PC on your CarrierNET LAN.

The CarrierNET system can operate on the existing power lines in your office or building, as long as they run in a straight path without electrical disruptions. The path is crucial when you are linking CarrierNET PCs on different floors of a building. CarrierNET can accommodate up to 255 nodes on a power line up to a mile long. As with normal cabling systems, however, the higher the number of workstations on the system, the slower the response time.

CarrierNET hardware installation is easy. You attach one of the CarrierNET box's cables to the power line and the other cable to your PC's serial port using a 25-pin connector. If your PC has a 9-pin serial port, however, you're out of luck; Carrier Current does not supply an appropriate adapter. The CarrierNET box contains a small radio transceiver, which uses Carrier Sense Multiple Access protocols to transmit at a rate of 38.4 kilobits per second over the power lines. In a new release of CarrierNET running under Artisoft's *LANtastic*, Version 3.0, Carrier Current promises to increase the transfer rate to 115.2 kbps.

Unlike other products in this review, the CarrierNET hardware posed no problems during our testing. It worked all around the building without a hitch. The transfer rates, however, were inconsistent; the transmission of a 50K file took as long as 61 seconds and as little as 36 seconds. These differences are likely to have stemmed from intermittent noise on the power lines.

Setting up CarrierNET Plus for printer sharing is just as simple as setting up CarrierNET for file transfers. First you should hook up your CarrierNET to some PCs and familiarize yourself with CarrierNET's printer-naming conventions. You can have up to sixteen CarrierNET Plus printer-sharing transceivers on a network, each with a unique name. Each transceiver uses switch settings to determine baud rates and the selection of an automatic form-feed.

HOW THEY DO IT: AC Power-Line LANs

Wireless systems operating over the AC power line use very low-frequency radio waves of about 200 kHz. Since they follow the metallic conductors of the power lines, it's important to keep the networked PCs together on the same power-line system without any intervening transformers or other electrical devices blocking the path.

The throughput of these systems is limited both by the low-frequency narrow-bandwidth radio signals and by the RS-232C link to the client PCs. To their credit, the two products that were reviewed in this category, CarrierNET and POWERNet, are easy to install and not too expensive. ■

Each CarrierNET Plus box is equipped with both serial and parallel printer ports.

The optional *ExcellNET* software adds file-transfer and e-mail capabilities to CarrierNET, and like the hardware it's easy to install: you simply answer a few questions from a menu. But *ExcellNET* has its limitations. Its lack of support for virtual drives can cause problems when several people want to access the same data files simultaneously. To avoid this, install a separate serialized *ExcellNET* floppy disk in each CarrierNET PC or expect to see a serial conflict message later in your installation.

CarrierNET is a fairly well-designed AC power-line alternative to conventional LAN connections. Buy Carrier Current's optional add-ons and you have a sound hardware/software system, basic peripheral- and file-sharing functions, and e-mail capabilities. You may be giving up virtual drive support when you use the *ExcellNET* software, but CarrierNET's easy installation and convenience make up for the loss.

CarrierNET
SUITABILITY TO TASK

File transfer	■■■
Printer sharing	■■■
E-mail	■■■
Database access	

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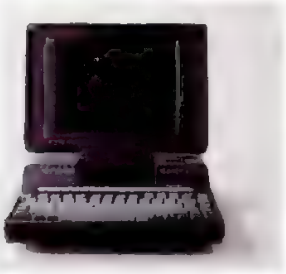

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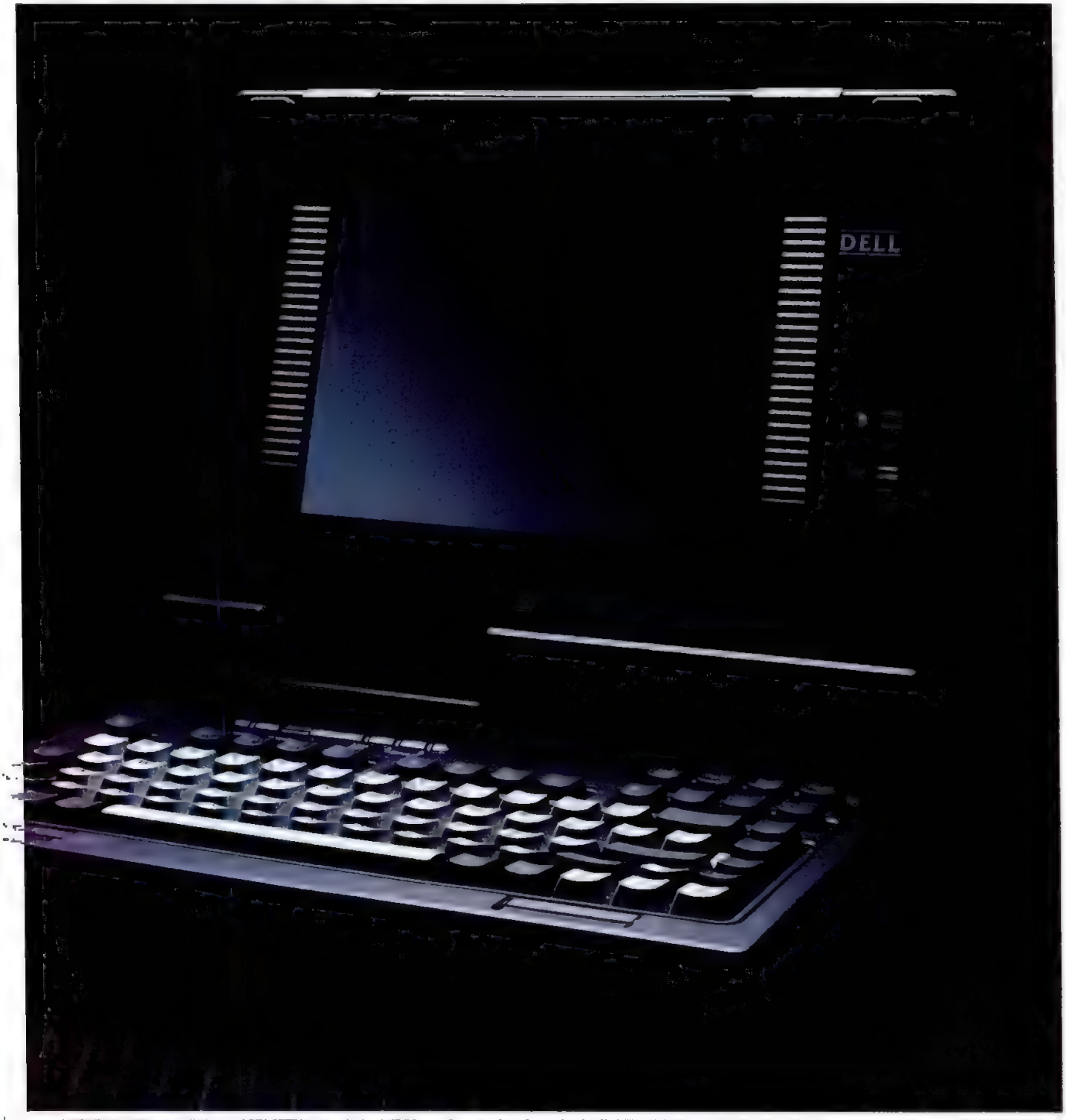

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CIRCLE 527 ON READER SERVICE CARD

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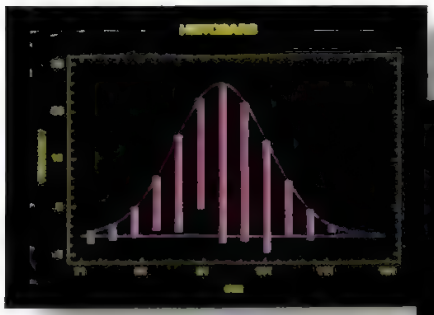

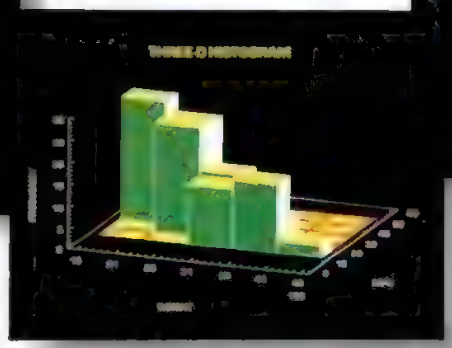

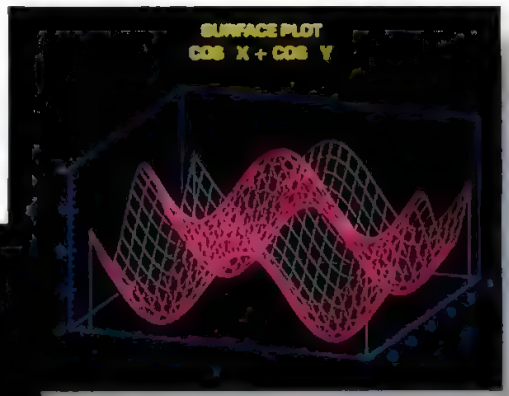

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O'NEILL COMMUNICATIONS INC.

LAWN

by Kimberly Maxwell

Freedom from all cabling is a lofty goal, and LAWN (The Local Area Wireless Network) from O'Neill Communications almost achieves it. Each $495 LAWN transceiver box sends and receives data using radio signals transmitted through the air instead of over power lines. This means that LAWN isn't limited by the transformer and wiring problems of carrier current radio systems. The only cable you'll need for this setup is the one that supplies the power.

In a simple network environment, LAWN functions as a good alternative to standard cabling. Its UHF radio spread-spectrum technology operates in the band from 902 to 928 MHz, allowing you to share printers and other peripherals, send or receive electronic mail, and transfer files. LAWN also lets you set up stand-alone printers and other RS-232 devices as part of the network. (Specific LAWN boxes are available for PCs, printers, and modems, but the only differences among all these versions are in the RS-232 cables supplied.)

The software requires 110K RAM, though a TSR program within the software needs just 40K. If you want to disable or enable the program, you simply enter LAWNOPT OFF or LAWNOPT ON. We ran LAWN with laptops, 33-MHz 386 PCs, and several AT-clone computers. Everything worked the first time with no hiccups.

LAWN does have some drawbacks, however. Unlike its UHF cousin ARLAN, it is incompatible with Novell's *NetWare* as well as other common LAN operating systems. It doesn't support network applications that must share files. Each LAWN unit can communicate with only one other unit at a time. And the PC LAN Labs crew discovered that LAWN may conflict with other radio-frequency sources, most notably a burglar alarm system's motion detector (as described in the introduction to this article).

Nevertheless, it's evident that a lot of good planning went into the design of the LAWN system. The hardware and software package takes only a few minutes to install. First you hook up the LAWN transceiver to your computer, printer, or modem; special cables for each type of connection are included with every package. Next you plug the adapter into any AC outlet. Finally, you configure the system by answering a few questions posed by the menu-driven software.

The main menu makes the program simple to use. A status area in the upper-right-hand corner tells you at a glance the number of mail messages you have, the number of messages waiting to be sent from your out-box, and how many print jobs are waiting. Each LAWN unit gets a special number, which acts as a network ID and as a security feature controlled within the software.

File transfers take place in LAWN's e-mail system. You simply attach a file or multiple files from a particular directory to an e-mail message and send the material over the radio waves to a receiving LAWN unit.

Print commands are also manipulated from LAWN's main menu, but you need to be sure that your LAWN printer unit is properly linked to the printer's RS-232 connection and that it is communicating with other LAWN units on your system. To do this, you can either select the Printer Options menu or find out the printing status from the main menu. Print jobs are spooled on the hard disk of the sending computer. If the LAWNs are busy, the computer simply waits its turn to proceed with printing.

The 16-ounce LAWN transceiver comes with all the necessary software for e-mail, file transfers, and peripheral sharing. You also get an adapter that plugs into a standard AC outlet and cables with 9-pin and 25-pin RS-232 serial port connectors. Since LAWN uses serial port connections, you can think of it as a wireless version of a zero-slot LAN (see "Zero-Slot LANs," April 24, 1990).

The transceiver has four indicator lights on the front panel. Together, they give the status of the LAWN network. The red Power light indicates that the box is receiving power; if it blinks, you are receiving a new mail message. The green Traffic light tells you that LAWN is "hearing" traffic on the selected channel and the network is in use. When you configure your LAWN network, you select from four available channels or frequencies. If you wish to set up several LAWN environments within the same office or building without causing interference, you can select a different channel for each network.

The green Connected light tells you that your machine is communicating with another PC using LAWN. This light gives a signal that the PCs are sending or receiving data; it will not illuminate if your LAWN is receiving a mail message. The green Transmit light turns on when your LAWN

HOW THEY DO IT: Radio-Wave LANs

The ARLAN 450 and LAWN transceivers exchange data using radio waves at a frequency of over 900 MHz. LAWN runs at very low power and is subject to disruption from local sources of radio signals. Moreover, its operation is limited to approximately 500 feet, though it is very easy to set up. With the proper antenna, ARLAN 450 can operate at much longer distances, and it lets you run *NetWare*.

The systems' throughput is largely determined by the type of connection between the transceiver and PC. Like all wireless networks, these provide a lower throughput rate than typical wire-based LANs. ■

FACT FILE

EDITOR'S CHOICE

LAWN
O'Neill Communications Inc., 100 Thanet Circle, #202, Princeton, NJ 08540; (609) 924-1095.
List Price: $495.
Requires: 512K RAM and RS-232 serial port for each PC, DOS 2.0 or later. Hard disk recommended.
In Short: LAWN uses spread-spectrum technology to perform file transfers, share peripherals, and send or receive e-mail messages. Although this system is not a full-blown local area network, it is a good alternative for those who need simple LAN services.

CIRCLE 550 ON READER SERVICE CARD

LAWN

SUITABILITY TO TASK

File transfer

Printer sharing

E-mail

Database access

is sending data to another LAWN on the network.

LAWN's maximum range for transmitting data is 500 feet. You can extend the range another 500 feet by using a LAWN box as a repeater or what O'Neill Communications calls a Via. The Via works like a microwave repeater tower that receives and resends telephone calls, and it can be handy when your LAWNs have obstructions like thick walls or floors between them.

You're unlikely to need support, but if you have any questions or problems, O'Neill Communications provides a toll-free number and a one-year warranty on the hardware and software.

LAWN's simple installation and menu-driven software make the product a friendly one to use. But if you need a high-powered local area network that offers file sharing and network applications support, you should probably look elsewhere.

HOW THEY DO IT: Infrared LANs

Light-wave technology is used by the Photolink system, in which each transceiver can connect to up to four PCs and Macintosh computers using RS-232C or LocalTalk cabling. The transmission distance is limited to about 70 feet, and even this is assuming that nothing blocks the path of the light beam (which can travel in a straight line or be bounced off a surface within view of both transceivers).

With its high throughput rate, the approach is potentially ideal for open office areas or offices with internal windows. You must provide software such as *TOPS* to control peripheral sharing. ■

PHOTONICS CORP.

Photolink

by Paul Ferrill

An office without walls is the perfect candidate for the $1,195 Photolink. Using infrared technology, it connects several computers via light beams instead of the radio waves used by other products in this roundup. Photonics Corp. sells only the hardware, but you can add third-party LAN programs like *TOPS Network Software* to use virtual drives and LAN functions such as printer sharing and electronic mail.

All of the Photolink units on a common network must see the same patch of wall or ceiling in order to read each other's light beams. Photolink isn't designed for offices with walls; rather, it's intended for use in offices that were constructed with room dividers or what interior designers call "modular furniture." The light beams must be aimed so that they aren't constantly interrupted by people walking past.

Nevertheless, Photolink also works for building-to-building communications over

FACT FILE

Photolink
Photonics Corp., 200 E. Hacienda Ave., Campbell, CA 95008; (408) 370-3033.
Requires: RS-232 or PhoneNET connector, LocalTalk network.
List Price: $1,195 (separate versions for RS-232 and LocalTalk).
In Short: This cable-replacement device uses infrared light beams for the connection. Its throughput is limited by the LocalTalk and RS-232C connections that link it to each PC.

CIRCLE 601 ON READER SERVICE CARD

SUMMARY OF FEATURES: WIRELESS LANs

Products listed in ascending price order

Each of these wireless LANs uses a menu-driven network operating system, either in the form of bundled proprietary software or a third-party system like *TOPS* or *NetWare*. In each case, the system permits file transfer, e-mail, and printer-sharing functions.

	CarrierNET	POWERNet	Photolink	LAWN	ARLAN 450
List price (per node)	$199	$279	$299	$495	$1,500
Wireless LAN technology	AC power line	AC power line	Infrared	UHF radio	UHF radio
HARDWARE					
Hardware type	Box (1.5 x 3 x 5 inches)	Box (2 x 3 x 5 inches)	Box (7 x 4 x 6 inches)	Box (2 x 4 x 7 inches)	Full-length adapter card, antenna
Serial/parallel port connections	■ / ❑	■ / ❑	■ / ❑	■ / ■	❑ / ❑
25-pin plug provided for RS-232	■	■	❑	■	N/A
9-pin plug provided for RS-232	❑	❑	❑	■	N/A
Power source	CarrierNET adapter	POWERNet adapter	Separate power supply	Separate power supply	PC
SOFTWARE					
Network operating system supported	Proprietary	Proprietary	*TOPS Network Software*	Proprietary	*Advanced NetWare 286*
RAM required	256K	256K	None	110K	None
Sold separately	■	■	■	❑	■
Operates as a TSR	❑	■	■	■	■
Supports virtual drives	❑	❑	■	❑	■
Peripheral utilities	■	■	■	■	■
Security feature	■	■	■	■	■

—Editor's Choice ■—Yes ❑—No
N/A—Not applicable: the product does not have this feature.

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restricted distances—up to 70 feet or so. But be aware of the drawbacks: you may lose network communications in heavy weather, and Photolink's Class A FCC certification restricts the product to use in offices only.

Current versions of the hardware support PhoneNET, LocalTalk, or RS-232 links. Each Photolink unit can handle up to four computers and is a snap to install. It comes individually packaged with its own power supply and RJ-11 cable. The optical head looks like an alien from a Disney movie; it's mounted on a swivel base that connects to a mounting bracket designed to fit over most office partitions. Photonics also provides Velcro tape for mounting the unit on other surfaces without using the clamp.

Once you mount the optical unit, a simple procedure enables you to align it. You point each optical "head" to the same general location on the ceiling or a common wall. Each unit has two indicator lights in the rear of the optical head that blink in distinctive patterns to aid in the alignment process. If the units can't "see" each other a combination of red and green lights will alternate. A flashing green light means "all systems go." Once you've aligned the units, all that's left is to connect each optical unit's power cord and a cable from each computer.

When your units are set up within a circular arc as Photonics recommends, the suggested maximum diameter between the farthest nodes is 70 feet, with the center being the "aiming" point of each unit. You can aim up to 32 Photolinks at the same target area; that translates into a maximum of 128 computers on one Photolink network. With the price of installing network cable approaching $1,000 per node in some metropolitan areas, the $1,195 price tag per unit is particularly attractive when you divide this figure by four nodes per unit.

Photolink

SUITABILITY TO TASK

File transfer	■■■■
Printer sharing	■■■■
E-mail	■■■■
Database access	■■■□

Photonics Corp.'s Photolink system uses infrared light beams to transmit data between clusters of PCs or Macs. The units can be set up in a direct line-of-sight arrangement, or the beams of light can be reflected off a wall or ceiling.

PC LAN Labs connected a three-node Photolink system and used *TOPS* with FlashCards to construct a network. Although *TOPS* in this configuration is not a fast network, we saw no difference in throughput whether we communicated through the Photolink adapters or transmitted the data through Farallon adapters and LocalTalk cabling.

Photonics offers a one-year warranty on parts and labor, with repairs performed at its plant in Campbell, California. Free technical support is also provided there and from regional offices, but the hardware is so simple to install that we doubt you'll ever use the number.

Photolink can't solve every connection problem, but if you need to connect stations in a line-of-sight environment, Photonics' infrared system is an interesting and innovative alternative.

POWERNET CORP.

POWERNet

by Kimberly Maxwell

POWERNet is a network designed for power users—AC power users, that is. This simple LAN transmits a low-frequency radio signal over standard power lines. It allows stations to share printers, transfer files, and perform e-mail functions. The POWERNet hardware consists of a black 3- by 5- by 2-inch box that connects to your PC's serial port at one end and plugs into a standard AC outlet at the other. POWERNet comes bundled with *Manylink* software and serial port testers to ensure that your ports stay active and functional. The price of the complete package is $279 per node.

That makes POWERNet an affordable option for a small business trying to avoid thick cabling strewn about the office. POWERNet also happens to have a faster file-transfer rate than its carrier current competitor, CarrierNET, though CarrierNET's transfer times were the most inconsistent among the products we tested. We put POWERNet and CarrierNET back to back during different trials of a 50K file transfer. POWERNet's median speed was just under 30 seconds, while CarrierNET's elapsed time on each trial was substantially slower.

POWERNet has the benefit of a simple, straightforward transmission scheme. It accepts digital data in an RS-232 asynchronous format from your PC, modulates the RF carrier signal using a frequency shift modulation, and then sends the signal through the power cord to the AC circuit. If there are no electrical disruptions along the wires, the data travels at 38.4 kilobits per second for up to a mile. POWERNet's CSMA (Carrier Sense Multiple Access) protocol simultaneously checks for errors and prevents data collisions.

At 200 to 217.480 kHz, POWERNet's radio signal frequency is so low that you aren't likely to notice interference from other radio systems. Instead, the signal just travels through the metal conductors in the standard electrical wiring and can be accessed from any outlet located on the same power transformer feed.

If there is a transformer or circuit disruption on the line, however, the RF signal might not reach the other POWERNet boxes. At first, PC LAN Labs testers had some difficulty finding PCs and power outlets that were compatible with POWERNet. We plugged the boxes into many kinds of computers using several different AC outlets. We noticed that combinations that worked with CarrierNET did

FACT FILE

POWERNet
POWERNet Corp., 1224 Santa Anita Ave., Suite C, S. El Monte, CA 91733; (818) 575-0817.
List Price: $279.
Requires: 256K RAM and RS-232 serial port for each PC, 105 to 135 volts AC, DOS 3.0 or later. Hard disk recommended.
In Short: POWERNet, assisted by *Manylink* software, transfers files, performs e-mail functions, and shares printers by transmitting a low-power, low-frequency radio signal along the power lines. Its cost and performance are moderate.

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PC MAGAZINE
EDITOR'S CHOICE
Chinon DS-3000
March 28, 1989

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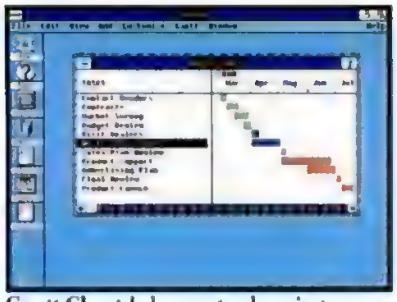
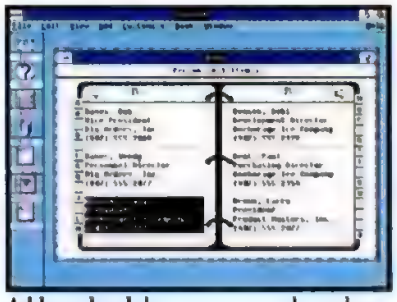
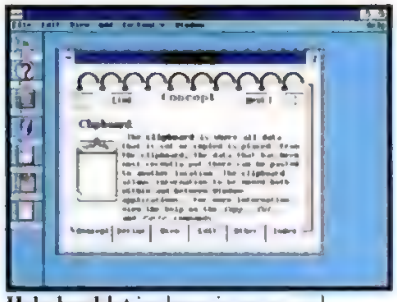
PROJECT BOARD



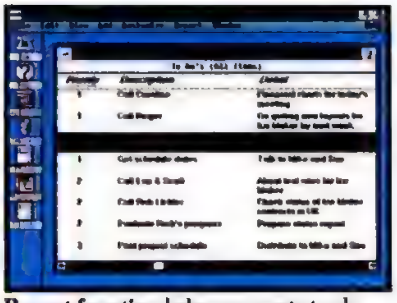
Gantt Chart helps you track projects, manage time.



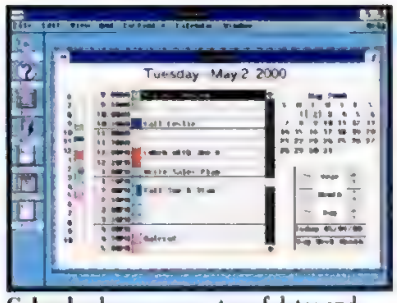
Address book keeps names and numbers at your fingertips.



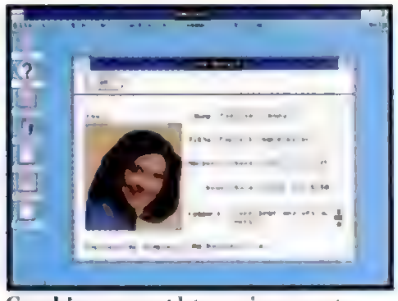
Help booklet is always in your reach.



Report function helps you create to-do lists and print professional-looking reports.



Calendar keeps you on top of dates and appointments, lets you view any day, week or month at a glance.



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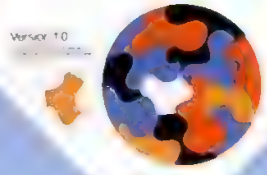
Version 1.0



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not always work with POWERNet. Nevertheless, in case of trouble, each POWERNet box contains a transformer power supply of its own, and POWERNet uses a standard internal fuse to defend itself against power surges; the fuse acts as a grounded surge protector.

The proper match of power outlets and PCs may take some experimentation, but installing the software is simple. Manylink Corp. developed it specifically for the POWERNet system. You do need to remember that the software is serialized and each machine requires its own floppy disk. The full program consumes 256K RAM, but you can run a TSR in 29K RAM instead and lower your memory usage.

One drawback is that the software does not support virtual drives. There are some other handy functions built into it, notably in the area of security. File-locking capabilities allow you to check out and check in utilities as if you were borrowing a book from the library. If someone else wants your utility, you can see who it is.

You can secure individual files or entire directories. The system comes with a built-in PUBLIC directory that every POWERNet user gets to access, but if you want your own special directory that virtually no other user can touch, *Manylink* lets you create it. You can even be a little generous and set aside files from your special directory in an out-box for users to capture.

POWERNet

SUITABILITY TO TASK

File transfer	■■■
Printer sharing	■■
E-mail	■■■
Database access	

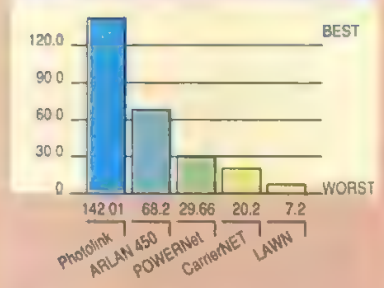
POWERNet Corp.'s support includes a toll-free number, and the hardware has a 30-day money-back guarantee and a one-year warranty.

Even though we had difficulty with the initial installation of POWERNet, we found the product to be a good alternative for those seeking a wireless LAN. The software is capable of performing simple network functions such as file transfers, electronic mail, and printer sharing, but it doesn't work in every combination of PC and wall outlet.

PERFORMANCE TESTS: WIRELESS LANs

No wireless network gives a throughput rate as high as typical network cabling schemes. This factor limits all the wireless products except Photolink and ARLAN 450 to simple file-transfer, e-mail, and printer-sharing functions.

Wireless LAN File Transfer Test
Throughput (kilobits per second)



Our **Wireless LAN File Transfer Test** involved sending a 50K file from one machine to another using DOS commands or similar commands from the network software. In each case, we ran the test repeatedly and reported an average result.

Each test was based on conditions appropriate for the individual system. While the setups are not precisely equivalent, they do represent typical installations and an attempt to put each system in its best light.

To test CarrierNET and POWERNet, we moved a 50K data file from the RAMdisk of one 12-MHz Dell System 200 to the RAMdisk of another. The transfer times varied widely, so we performed many test runs and found the median score for each product.

We used the same setup for LAWN, but the times became consistent only after we disconnected a local source of radio interference. All three of these products attach to the PC's serial port, but LAWN's maximum RS-232C signaling rate of 9.6 kilobits per second limits its performance.

We installed one ARLAN 450 adapter in a Dell System 325 file server running *Advanced NetWare 286*, Version 2.15. The client station was a Dell System 200.

We tested Photolink using the *TOPS Network Software*, FlashCard adapters, and Farallon connectors for LocalTalk. A Dell System 325 acted as the file server and a Dell System 200 was the client. This arrangement gave Photolink a direct connection into the PC's data bus and materially increased the cost of the installation. The upcoming version of Photolink, which connects through the serial port, will be limited by the maximum throughput of the serial connection.

The RS-232C connections between the slower units and their PCs limit their throughput more than the inherent limitations of the airwave or power line. The faster performers have internal adapter-board connections between client PCs and the signaling devices

TELESYSTEMS SLW INC.

ARLAN 450

by Kimberly Maxwell

An antenna jutting out of a PC may be an unexpected sight, but with ARLAN 450 it's just the thing for tuning in a *NetWare* network. This package, from Telesystems SLW, lets your PC take to the airwaves and perform Novell LAN functions without any physical connections to the server itself.

The $1,500 cost per node is a bit high, but ARLAN gives you *NetWare* connections as no other wireless alternative will. Along with the card, the package includes the necessary device drivers for running under Novell's *Advanced NetWare 286*, along with a standard 3-inch monopole antenna (which you attach to a special port on the card) and a strong manual with a thorough troubleshooting guide.

ARLAN's small radio transceiver housed in a metal case on the card sends and receives the packets of data.

The card uses spread-spectrum technology, or SST, for network transmissions. A small radio transceiver housed in a piggyback metal case on the back of the card sends and receives the packets of data. SST modulates the radio waves transmitted by the card at up to 1 watt of power. The card operates at around 915 MHz with a signaling rate of 230 kilobits per second, using a multiple-access protocol similar to the cabled CSMA (Carrier Sense Multiple Access) system. The major difference between CSMA and SST is that spread-spectrum synchronization causes less interference to surrounding signals and overrides intruding signals, which means greater security for ARLAN's transmissions. Unlike LAWN—the other radio system we tested—ARLAN worked in spite of the radio signals generated by the PC LAN Labs burglar alarm's motion detector.

Throughput with ARLAN is slower than with wired LAN systems. Therefore, when installing ARLAN, it's a good idea to copy your .EXE and .COM files to the

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Mega Model	[illegible]	MegaDraw $195, List $295, MegaShade $395
MicroStation PC 3.0	[illegible]	Customer Support Libraries $1,000.00
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Source. Byte Magazine

BYTE MAGAZINE SAYS...

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DesignCAD 3-D and DesignCAD 2D are available from most retail computer stores, or you may order directly from us. If you have questions about which program to purchase please give us a call. All you need to run DesignCAD 3-D is an IBM PC or compatible computer with 640 K RAM memory and a hard disk. Both products support most graphics cards, printers, plotters and digitizers. Free information and a demo disk are available by faxing (918) 825-6359 or telephoning:

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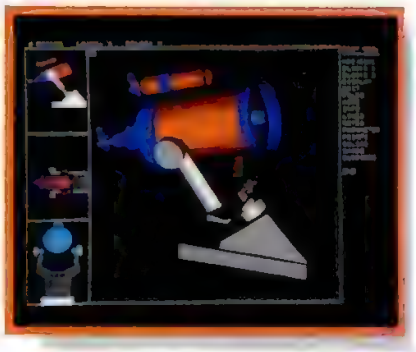

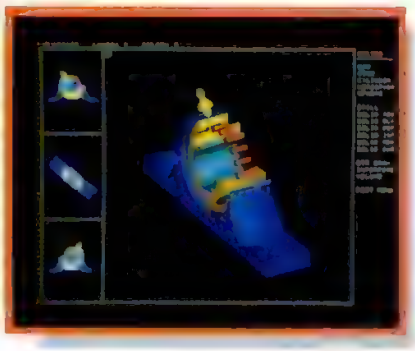

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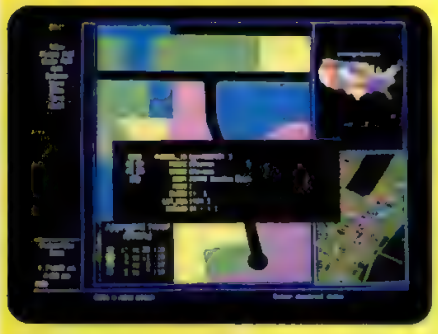

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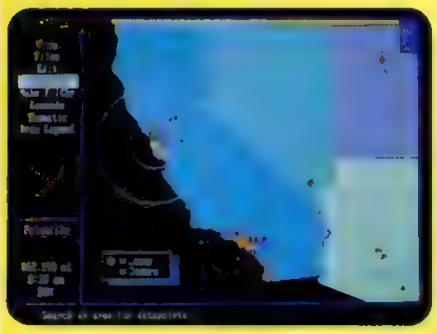

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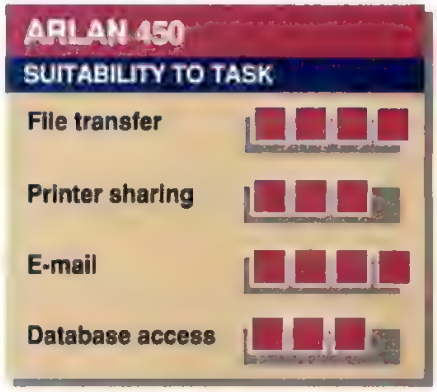
CIRCLE 291 ON READER SERVICE CARD

particular workstations that need them. That way, the stations can run applications directly instead of having to pull them from the file server. Telesystems recommends that ARLAN be used for file retrieval and storage, e-mail, and printing functions. One ARLAN system can support up to 100 PCs, but as with any network, the more PCs you connect, the slower the response time.

To install an ARLAN system, you insert the ARLAN card directly into each client PC, put one card into the *NetWare* server, connect an antenna to each card, ascertain that your *Advanced NetWare 286* is configured for ARLAN, and zap! you have a full-blown network operating system without using any cables or wires. Standard Ethernet and other cable connections between the server and clients still work, but ARLAN's spread-spectrum radio system enables portables and hard-to-reach stations to be connected as well.

The maximum distance between stations depends on the antennae you use, their relative elevation, and the material between them. With 1 full watt of power at each end, you can expect coverage of a mile or more if there are no intervening structures. But different ranges call for different antennae. With remote desktop PCs in the same office, an antenna with a quarter-wavelength monopole will do. For building-to-building communications, a 3-foot antenna, much like a television antenna, is more suitable. Whichever type of antenna you use, try to place your PCs well away from any large vertical metallic surfaces, since they can cause a shielding effect. For example, avoid situating a machine between two filing cabinets.

Conflicts can also occur if several systems are set up in the same vicinity. To avoid this, ARLAN allows you to select different channels and signal-spreading codes. You use the same disk when you set up the file server and workstations, so they communicate within one system. Before you place the ARLAN cards into your PCs, make sure you determine the appropriate hardware settings and install the ARLAN drivers on your *Advanced NetWare 286* system. Afterwards, you set each card's jumper and switch settings and station address, then place cards into the server and each computer and attach the antennae.



ARLAN is compatible with Novell's *Advanced NetWare 286*, Version 2.1 or later, and with *ELS NetWare II*. Future ARLAN products will incorporate *NetWare 386*. The manual assists you with the *NetWare* server and workstation driver installation. If you have any problems with the linkage between your ARLAN cards and *NetWare* or with the ARLAN hardware, the manual includes a troubleshooting and maintenance section, and a technical support team stands ready to help you.

Because ARLAN 450 uses Novell's *NetWare* as its operating system, you get all the benefits of a complete network on a wireless LAN. The 3-inch antennae that mount directly onto the card act and react as if you had standard cabling connecting your PCs—but with somewhat lower throughput. You'll pay more for ARLAN, but you'll get the fullest set of features currently available in a wireless LAN. ■

FACT FILE

EDITOR'S CHOICE

ARLAN 450
Telesystems SLW Inc., 85 Scarsdale Rd., #201, Don Mills, Ontario, Canada M3B 2R2; (416) 441-9966.
List Price: $1,500.
Requires: 128K RAM per PC, *Advanced NetWare 286* 2.1 or *ELS NetWare II*.
In Short: ARLAN 450 is a powerful wireless LAN using network cards and antennas to communicate among PCs. Each card has a small built-in transceiver and uses spread-spectrum radio technology to perform LAN functions. The price is high, but this system works where there are no other alternatives.

CIRCLE 603 ON READER SERVICE CARD

Frank J. Derfler, Jr., *is workgroup systems editor of* PC Magazine. **Paul Ferrill** *is an electrical engineer who works in defense systems. He is a frequent contributor to* PC Magazine. **Bill Machrone** *is editor-in-chief and publishing director of* PC Magazine. **Kimberly Maxwell,** *a newspaper journalist, is a frequent contributor to* PC Magazine.

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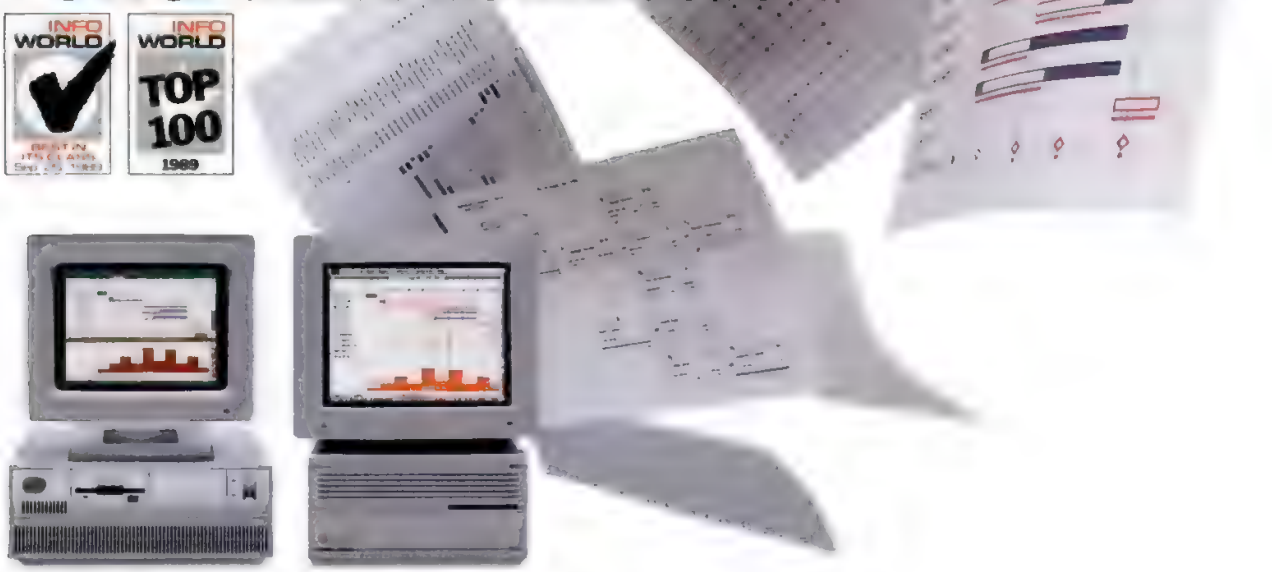

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CIRCLE 374 ON READER SERVICE CARD

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POWERsave can back up all workstation disks on any of these networks, plus Novell's bindery files, trustee data, directory and file info, extended access rights, attributes, etc. and Banyan's Street Talk® names and access rights list.

PC MAGAZINE

POWERsave's performance is highly acclaimed by PC Magazine. Operating any tape drive to its maximum speed and capacity, POWERsave does a complete backup faster than other popular vendors do incrementals! PC Magazine benchmarked POWERsave with the Exabyte to be "roughly twice as fast as (Emerald's) VAST®Device" (the same drive)!..Jan.17, 1989

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The New World of HIGHER MATH

Derive, Macsyma, Maple, and Mathematica are packed with tools that make them much more than simple electronic blackboards.

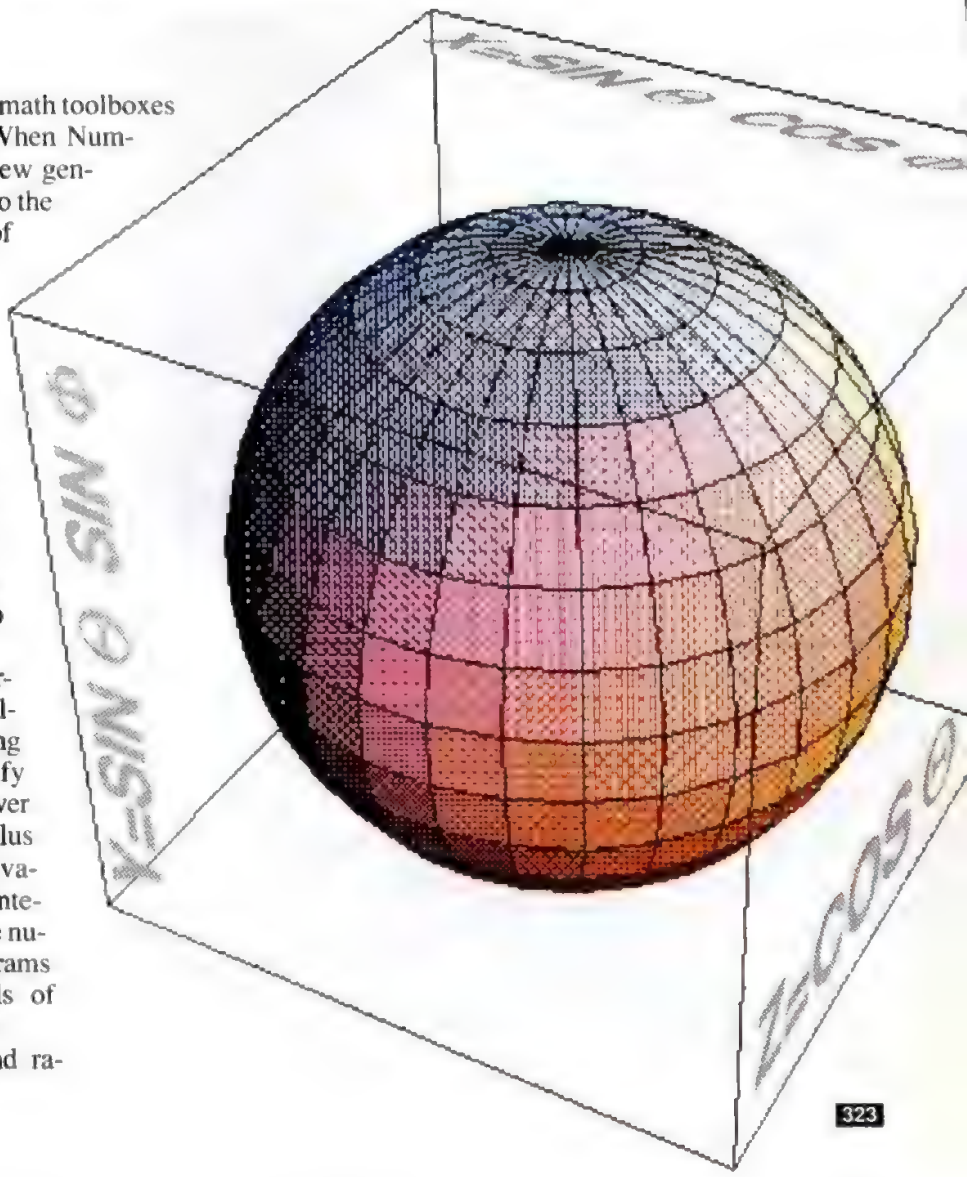
by Barry Simon

Since *PC Magazine*'s last review of math toolboxes ("Better Tools for Higher Math: When Numbers Count," March 14, 1989), a new generation of products has ventured onto the scene, bringing an increased level of mathematical power to the PC.

The new capability shared by *Derive*, *Macsyma*, *Maple*, and *Mathematica* is often called symbolic manipulation. This does not mean that these programs manipulate symbols on-screen, displaying *MathCAD*-like WYSIWYG mathematics (see the sidebar "Gauss and MathCAD: The Best of the Rest"). Rather, these symbols are abstract variables like the x and y familiar to algebra students.

These programs are capable of performing more than mere computer algebra (factoring polynomials or using trigonmetric identities to simplify multiple-angle formulas)—their power extends to calculus. Symbolic calculus is the ability to find symbolic derivatives and, in some cases, symbolic integrals. While other systems compute numerical derivatives, these programs compute derivatives and integrals of many functions in functional form.

They also do exact-integral and ra-



tional arithmetic, and make calculations with real numbers to arbitrary accuracy. Conventional programs like *MathCAD* and *Gauss* allocate a fixed amount of memory to each mathematical object. If an integer becomes too large to fit as an exact number, the programs display an error message or turn the integer into a real number of limited accuracy. These four packages increase the memory allocated to an integer as needed and can deal directly with rational numbers as ratios of integers.

Similarly, other programs allocate 4, 8, or 10 bytes for real numbers, limiting them to 16-place accuracy, at most. But the four toolboxes reviewed here can work to any level of accuracy you desire. You won't normally be interested in more than 16-place accuracy for final answers, but in the case of large numerical calculations, the round-off errors made at intermediate steps can add up and invalidate the answer. (Of course, computers are finite systems with limits, but these limits are so vast they are insignificant for most practical purposes.)

The price for accuracy is considerable: although these programs will work just fine for quick interactive-numerical calculations, you will definitely want to look elsewhere for your most serious number crunching.

Symbol crunching is only one of four main functions that the software must perform to provide a complete interactive-mathematical environment. Other required features are numerical calculations, graphics, and programming. *Mathematica* stands out for having graphical abilities comparable to the best graphics programs around; *Derive* is unique in that it does not have an associated programming language.

All programs, except *Derive*, support external sets of routines. *Maple* and *Macsyma* come with megabytes of such external packages, while *Mathematica* works with routines from many third-party developers. *Macsyma* checks the common rountines in a lookup table and automatically loads the correct external file; the others force you to look up the correspondence and manually load the routines.

Once again, all programs except *Derive* will output functions as Fortran, C code, or in a form suitable for setting with the TeX page-markup language. And *Macsyma*, *Maple*, and *Mathematica* demand PCs with real horsepower—an 80386 and several megabtyes of RAM. They are also memory hungry: they need from 5MB to 20MB of free disk space to run efficiently.

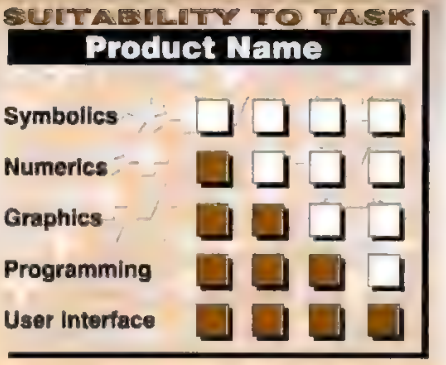
Our testing involved giving each package 20 problems to solve—13 were related to symbolic and numerical manipulations, three involved graphics, Fortran, or TeX output, and four asked for sample programs.

While our informal tests will help you get a better idea of which package best meets your current needs, you should be aware that another option may be on the way. *ScratchPad*, IBM's internal symbolic program for minicomputers, may soon appear in a commercial version for the PC. However, IBM has not publicly commented on the possibility. Until then, one of the four programs reviewed here remains your best choice.

SUITABILITY TO TASK: SYMBOLIC MATH TOOLBOXES

A complete interactive-mathematical environment has four vital elements: a complete set of symbolic manipulation features, speed in numerical calculation, thorough graphing capabilities, and a useful programming language. These four products have been rated for their suitablity to each of these tasks. Since the user interface plays an important role, it has also been rated.

The ratings translate as follows: 0—lacks feature or is not at all suited; 1—poorly suited; 2—some capability; 3—well suited; 4—ideal for the task, the best you can find for your PC today.



EDITOR'S CHOICE

- **Derive**
- **Maple**

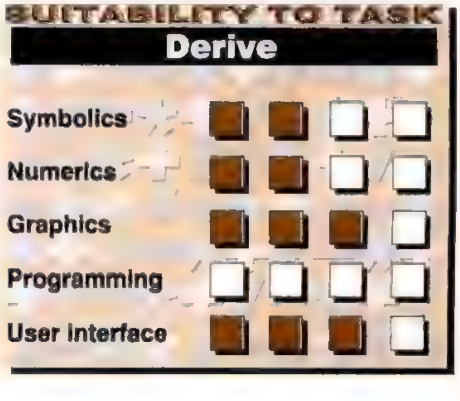
Programmable symbolic math toolboxes amaze us in ways that mere number crunchers do not. Anyone with real mathematical curiosity will love any of these programs, but overall, *Maple* is best suited for those who need a built-in programming lanugage. While its graphics are weak, its interface is acceptable and its symbolics are thorough and powerful. Also, out of the three programmable packages it is the easiest to learn and, to top it off, our informal tests proved it to be the fastest.

Derive scores points for its ability to run on even the lowliest of PCs and for having a price that you or your high school district can easily afford. It has a friendly interface and as much power as you'll need if programming and esoteric functions aren't a requirement.

Mathematica has many virtues—most notably its stunning graphics. The raison d'etre of these programs, however, is symbolics and *Mathematica* is immature in that area. Still, it has incredible promise and could well be top dog in a year or two.

DERIVE

The first noticeable detail about Soft Warehouse's Derive is that its hardware requirements are the least demanding of all four programs. It will run with acceptable speed on an XT-class machine and does not use a math coprocessor. *Derive*'s calculations with reals are sped by a method of rational approximation that



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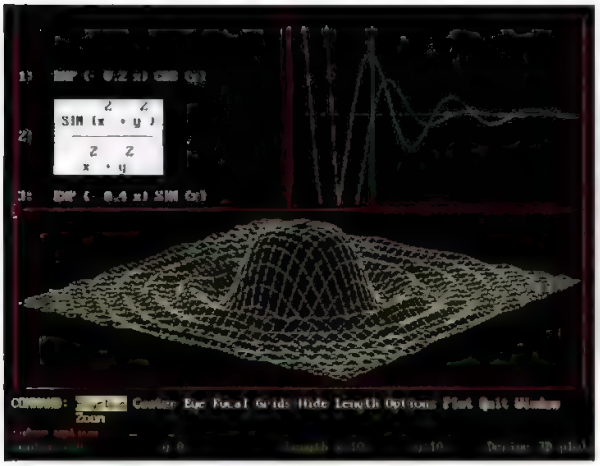
gains nothing from a coprocessor. And instead of the extra megabytes of free disk space that the other programs require, *Derive*'s basic executable file is only 220K. At $200, it's the bargain of the group.

However, *Derive* is less capable in some areas than its competitors. Most notably, it lacks a programming language, making it unsuitable for most research scientists. But for students or anyone interested in exploring the world of mathematics, it's an excellent choice. Even some researchers will find it acceptable for the occasional symbolic calculation.

Derive has all the basic symbolic math: manipulations of polynomials, trigonometric and hyperbolic functions, factoring integers, manipulations of symbolic sums, symbolic integration and differentiation. More-sophisticated functions like Bessel, zeta, or hypergeometric functions are missing, though. While you can define a Bessel function as an integral and calculate values, *Derive* won't use this definition in symbolic calculations.



Despite its low cost and basic hardware requirements, *Derive* produces excellent two-dimensional and three-dimensional graphs. And you can zoom in on plots for closer study.

FACT FILE

EDITOR'S CHOICE

***Derive*, Version 1.6**
Soft Warehouse Inc., 3615 Harding Ave., #505, Honolulu, HI 96816; (808) 734-5801.
List Price: $200.
Requires: 512K RAM, DOS 2.1 or later.
In Short: A symbolic math toolbox with all the trimmings, except for built-in programming. *Derive* is most notable for its friendly interface and modest hardware requirements. A good choice for educators.

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The program understands matrixes and vectors, has basic vector calculus, and finds eigenvalues, but it won't find eigenvectors and its matrix reduction is limited to row-echelon form. *Derive* does have some advanced features, like the ability to specify a variable as having a definite sign, but equation solving is limited. It can handle a single nonlinear function of one variable or several simultaneous linear equations, but cannot handle nonlinear equations in several variables unless you reduce them by hand to a sequence of one-variable-at-a-time problems. It has no built-in facilities for solving differential equations or finding Laplace or Fourier transforms, although Soft Warehouse has included an external file with some capabilities for solving ordinary differential equations.

Derive's numerics are the fastest of all on simple problems like integer factoring, but the program tends to slow down on more-complex problems.

The package supports both two- and three-dimensional graphs. You can plot more than one function on the same graph and use multiple windows for easy comparisons, zoom in and out on plots with a single function key, and move a cross hair whose coordinates you can read. Unfortunately, however, *Derive* offers no direct printer support; you are limited to what is provided by DOS graphics or third-party programs.

Its user interface beats that of the other programs. You can invoke a command line where you can insert all or part of the output or input of a previous command for further editing. *Derive* also has a first-letter-driven menu mode, which is not state-of-the-art but is miles ahead of most other math toolboxes. The only toolbox with a smoother interface is *MathCAD*, whose abilities complement rather than compete with *Derive*—so much so that MathSoft, the maker of *MathCAD*, also sells *Derive*.

Derive's weakest element is its lack of a programmable language. This is ironic, since Soft Warehouse used to manufacture *MuMath*, a highly programmable product (with limited symbolic abilities, however). But if you don't need heavy-duty symbol crunching or programming, its basic hardware requirements make it an attractive choice.

MACSYMA

Symbolics' $1,950 *Macsyma*, the oldest program in this review lineup, evolved from the MIT pioneering computer algebra project (also called Macsyma) that was started 20 years ago. This kind of history gives it an advantage: with two decades of bug-swatting behind it, *Macsyma* is bound to be reliable.

Additionally, because *Macsyma* has been around so long, it has had the chance to add routines in areas of mathematics not handled by the other programs, as well as to incorporate a richer set of routines in the common areas. For example, *Macsyma* has symbolic and not-just-numerical Fast Fourier transforms.

But despite its age and reputation it has some disadvantages, too. Some of the *Macsyma* kernel uses obsolete technology: for example, factoring large integers takes over 200 times longer than in *Derive*,

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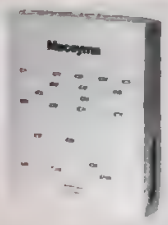

***Macsyma*, Release 415.25**
Macsyma Division of Symbolics Inc., 8 New England Executive Park, East Burlington, MA 01803; (800) MACSYMA, (617) 221-1250.
List Price: $1,950; for academic institutions, $1,250.
Requires: 386-based PC, 4MB RAM, 30MB free disk space, DOS 3.0 or later. Mouse recommended.
In Short: Although admirable for its breadth, depth, and reliability on symbolics, *Macsyma* has only marginal graphics capabilities, a poor interface and very slow numerical processing.

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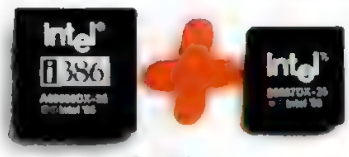

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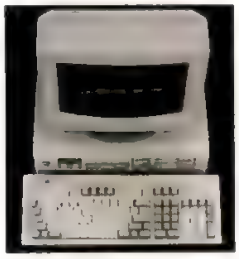

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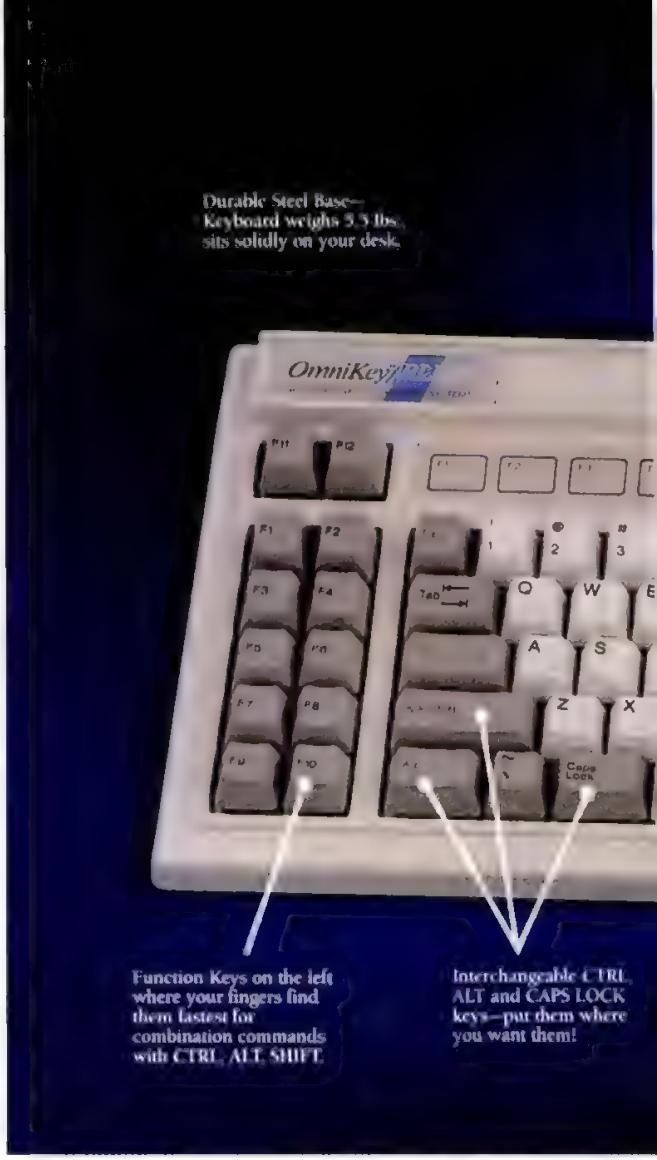

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probably because the recent progress in that area has been built into the younger *Derive* but has not yet been added to *Macsyma*.

Macsyma runs under *Microsoft Windows*. However, it runs in imitation of the DOS command line, except for the help system and the use of scroll bars to see what has moved off-screen. The only editing key is Backspace, and you can recall only partial previous commands by cutting and pasting with a mouse. None of these programs has state-of-the-art interfaces, but *Macsyma*'s interface is the furthest from the expectations of today's PC users.

GOOD HELP IS HARD TO FIND

Macsyma partially makes up for its inconveniences with the best help system of all the packages reviewed here. Although it doesn't have a keyword search or the ability to explore a list of previously consulted help screens, it can trace through several layers of menus to find individual topics and aid you with syntax or examples.

Symbolics is *Macsyma*'s strongest point. It is unique in its ability to check things like the special value of the integral of x^n when n=0. However, numerical calculations were very slow on our informal tests: *Maple* did each of the 20 simple problems in 32 seconds or less, but *Macsyma* exceeded our 10-minute time limit on four problems and took over 2.5 minutes on another two.

The program's on-screen graphics are acceptable. You can plot in 2-D and 3-D and adjust things like viewpoint, but you cannot view multiple graphs. If you want to place the graph in a document or print out a hard copy and have only the runtime version of *Windows* that comes with

SUITABILITY TO TASK

Macsyma

Symbolics	■	■	■	■
Numerics	■	□	□	□
Graphics	■	■	□	□
Programming	■	■	■	□
User Interface	■	□	□	□

Gauss and MathCAD: The Best of the Rest

by Barry Simon

Do symbolic math powerhouses, like the ones evaluated in this issue, make the rest of the math toolbox market irrelevant? Far from it, as *PC Magazine*'s two Editor's Choices from last year continue to prove.

MathCAD, Version 2.5, remains the product of choice for those who want an easy-to-use numerical program. You do have to remember a few arbitrary keystrokes like "@" for a plot region or "&" for an integral, but the rest is easy. Hitting the "&" key displays an integral sign with blocks in which to place the arguments. You move your cursor to the blocks, fill them in, strike a key, and the intergral is calculated. Since the graphical mode lets you see formulas as you'd write them, remembering the process of a saved calculation is simple.

The *MathCAD* program has just about any numerical tool you could possibly want, including lots of special functions, statistical functions, curve fitting, vectors and matrixes, complex numbers, and equation solving. The upgrade from Version 2.0 adds 3-D plots to the existing 2-D plots, and changing viewpoints is now done with an elegant pop-up menu rather than arcane commands.

MathCAD has no symbolic manipulation features and no programmability. Its graphs are called plots and that is exactly what they are—don't expect the presentation-quality graphs you get from *Mathematica* or *Gauss*. While computation speeds in the latest version have improved by as much as a factor of two, it remains slow at displays, especially 3-D surfaces. If your needs are numerical and you care about the speed and ease of setting up a problem rather than the display and calculative swiftness, *MathCAD* is a great choice.

GAUSS-386 AND GAUSS 2.0

Gauss is a number cruncher par excellence. It is primarily intended as a higher-level programming language—a language with built-in mathematical knowledge—that runs at speeds close to that of custom-written C or Fortran programs. *Gauss* comes in two versions: a DOS version and a 386 version that uses the Phar Lap DOS extender in order to access much larger data sets and more-complex programs.

Its interface is rather spare. You can write code in your own favorite editor or in the built-in editor loosely based on *Brief*. You can also issue interactive commands, but only at the command line; you don't get the benefit of menus or any on-line help for the language. Scrollback is limited to only two screens, although you can cut commands to a buffer for later reissue.

Gauss has an enormous range of mathematical functions and procedures, especially those built around matrixes, and it also gives you access to low-level operations like file handling.

You have your choice between quick graphics or publication-quality. Its high-quality graphs produced in two and three dimensions are among the best of any math toolbox, including *Mathematica* and *MathGraf*.

But *Gauss*'s strong point is speed. It was 5 to 50 times faster on the test problems than any other program discussed here with one exception: *Mathematica*, which has five-specially tailored numeric commands like NSum, which produced times comparable to *Gauss* and offered higher precision.

Gauss-386 and Gauss 2.0
Aptech Systems, 26250 196th Place South East, Kent, WA 98042; (206) 631-6679.
List Price: Gauss-386, $695; Gauss 2.0, $495 .
Requires: *Gauss-386*, 386-based PC, 2MB RAM, 700K RAM free disk space, math coprocessor, DOS 3.0 or later; *Gauss* 2.0, 640K RAM, 380K free disk space, math coprocessor, DOS 3.0 or later.
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***MathCAD*, Version 2.5**
MathSoft Inc., 201 Broadway, Cambridge, MA 02139; (800) 628-4223, (617) 577-1017.
List Price: $495; academic discounts available.
Requires: 640K RAM, DOS 2.0 or later.
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Macsyma, you're out of luck. With the full *Windows* package, you can use the clipboard to transfer to *Windows Paint* and print or save to a file from there, but only at screen resolution.

Unfortunately, the product costs almost three times more than *Maple* or the noncoprocessor version of *Mathematica*; it is copy protected with a parallel port block that is supposed to be transparent but wasn't in our experience; additionally, it uses an old version of Phar Lap Software's *386/DOS-Extender*, which is not compatible with *QEMM-386* or *386max*.

For certain symbolic functions, *Macsyma* is the program of choice, but given its limitations in numerical calculation and graphics, as well as its user interface, price, and copy protection, most other tasks will be better served by one of the other products.

MAPLE

Given *Macsyma*'s long history and the media attention that *Mathematica* has garnered, *Maple* may be the least well-known of the programmable math toolboxes, but it deserves to be the best known. Out of the four important components that make up a unified toolbox, this $695 product from Waterloo Maple Software is weak only in the graphics area.

Maple uses a command-line interface, but it has most of the amenities—including an editable command line (similar to that of a word processsor) and the ability to recall the last 100 commands for reissuing. You can also find commands in this stack. The F1 key calls up on-line help, if only in the form of panels for each command. The biggest problem is that material scrolled off-screen cannot be recovered, although Multisoft's *PCKSCRN* utility seemed to fix this. The only other missing feature is *Mathematica*-like command completion.

Maple has a rich set of routines that makes it roughly comparable to *Macsyma* in symbolics power (*Maple*'s strength lies in routines directed at pure mathematicians; *Macsyma*'s, in those geared toward engineering). It ran the gauntlet of almost all 20 test questions without the slightest stumble. The program even had routines to solve the four problems I created without any expectation of finding solutions.

Its symbolics do have one glitch, however. Once answers begin to get long, they are not logically ordered. For example, when asked to factor the sum from 1 to n of the 30th powers, one factor is a 28th-degree polynomial. The other programs write the 29 terms of the polynomial in either ascending or descending power order. In *Maple*, the n^3 term comes first, then the n^{19}, then the constant, and so on. Locating any particular term is difficult.

Overall, *Maple* was the fastest program for numerical calculation. While *Derive* was slightly faster on some of the simpler problems, *Maple* generally beat it. It was especially impressive in determining exact evaluations of infinte integrals and sums.

Maple's language will feel familiar to those who have used Pascal or C. Its debugging facilities are a little primitive, but that's true of the other programs as well. *Maple* allows you to trace procedures, and it comes with a syntax-checking utility called *Mint*, clearly patterned on C's *Lint*. You can also invoke an editor from *Maple* or replace it with your own favorite.

The one real blemish in the current version lies in its graphics capabilities. Graphics are much more machine dependent than the underlying kernel, and while *Maple* has a five-year history, this is the first release for PCs. Although versions designed for other machines support 3-D graphs, the PC version is not yet able to do so (it is promised, however, for the next release). *Maple* can plot 2-D graphs and direct them to a PostScript file, but no other printer support is provided. You'll need an external print-screen program that works with the monitor and printer you already have.

It's easier to learn and use *Maple* than *Macsyma* or *Mathematica*. Despite the program's functionality, its documentation is approachable, unlike *Macsyma*'s, which is overwhelming manual. *Maple* is really the best of the four—at least for anyone who doesn't have heavy graphical needs or require the special strengths of *Macsyma*.

MATHEMATICA

Excellent graphics and a powerful programming language help Wolfram Research's *Mathematica* come closer to creating a completely interactive mathematical environment than any of the other programs reviewed here. However, this brainchild of Stephen Wolfram (principle architect of *SMP*, a minicomputer symbolic math program of the early 1980s) is not yet the mature product it strives to be, as it lacks a richness of symbolic procedures.

Mathematica's non-math–coprocessor version sells for $695 (prices for different coprocessor versions vary depending on the chip used). The program has the best

SUITABILITY TO TASK
Maple

Symbolics	■	■	■	■
Numerics	■	■	■	□
Graphics	■	□	□	□
Programming	■	■	■	□
User interface	■	■	□	□

SUITABILITY TO TASK
Mathematica

Symbolics	■	■	■	□
Numerics	■	■	□	□
Graphics	■	■	■	■
Programming	■	■	■	□
User interface	■	■	□	□

FACT FILE
EDITOR'S CHOICE

***Maple*, Version 4.3.1**
Waterloo Maple Software, 160 Columbia St. West, Waterloo, Ontario, Canada N2L 3L3; (519) 747-2373.
List Price: $695.
Requires: 386-based PC, 2MB RAM, 10MB free disk space, 80387 math coprocessor, DOS 3.3 or later.
In Short: A full-featured symbolic toolbox, *Maple* has the fastest overall numerical processing and a wide array of symbolic functions. It's also easy to learn.

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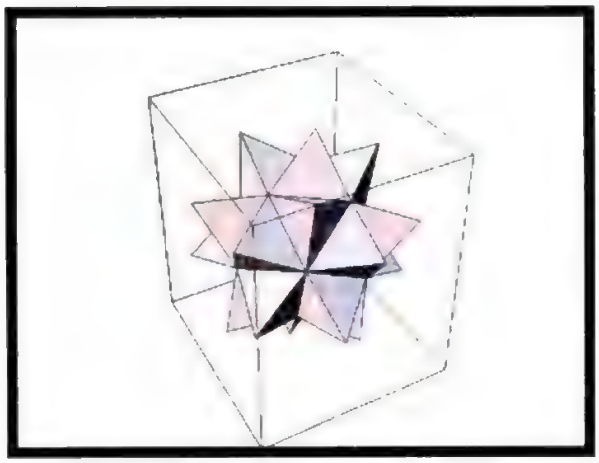
user interface of the three programmable symbolic toolboxes: while it is basically command-line-driven with no menus to guide you, you can access screens that have scrolled away and retrieve previous commands for editing. Its neatest feature is command completion: type the beginning of a command, hit F2, and get a pop-up box of all commands that start the same way. (A promised *Windows* version to appear this year should boost the interface's usability even more.)

You access help with any command by typing "?" followed by the command, but since there is no general help feature you must consult the manual for functions whose names you don't already know. The manual itself is a mammoth-sized 747-page hardcover book, which serves as a good reference for symbolic manipulation in general.

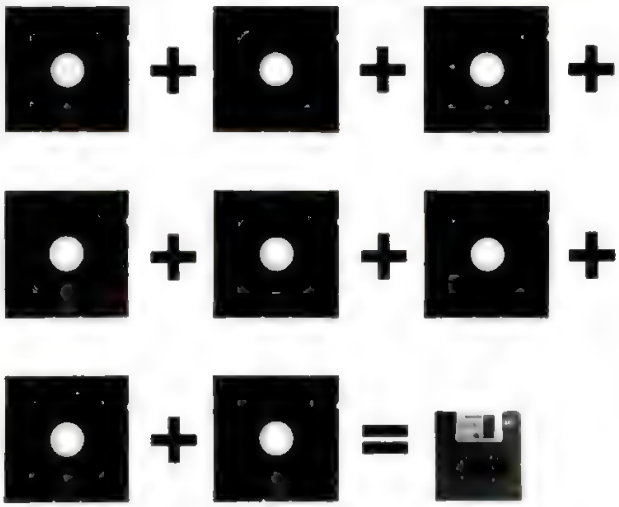
Mathematica's colorful graphing features are outstanding. You get superb two and three-dimensional graphs, along with considerable flexibility to rotate and change your viewpoint easily. An animation feature helps you study dynamics. The only program with built-in LaserJet support, *Mathematica*'s output is exceptional. The software also supports PostScript printers and creates .EPS files; it produces graphics with its own version of display PostScript.



***Mathematica* wins the graphics prize easily with its ability to produce dramatic images like this polyhedron. Less-complicated equations can lead to equally impressive images.**

But *Mathematica*'s symbolic abilities, while considerable, are neither as deep nor as broad as those of *Maple* or *Macsyma*. Of the sample problems, there were four that *Mathematica* couldn't handle; in addition, none of the four sample programming functions involved a built-in capability. For example, it could differentiate $x^{10}\cos(\ln x)$, but it was then unable to integrate the resulting derivative (the procedure to do this integral is in a beta module for the next version of the kernel).

The program's numerical speed is mixed. There are five special numerical commands that are designed for handling sums, products, roots, integrals, and Bernoulli numbers; these commands are light-



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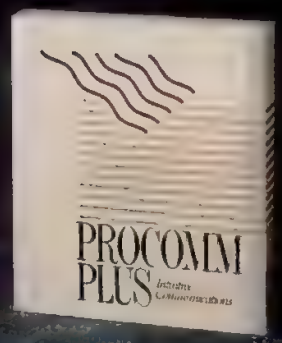

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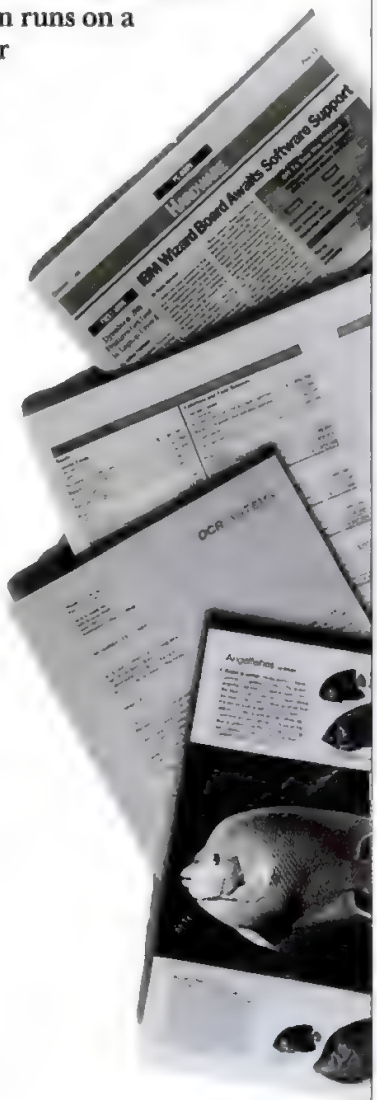

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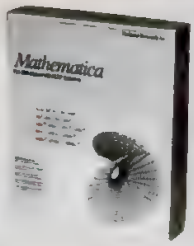

***Mathematica*, Version 1.2**
Wolfram Research Inc., P.O. Box 6059, Champaign, IL 61826; (800) 441-6284, (217) 398-0700.
List Price: Non–math coprocessor version, $695; 80287/80387 coprocessor versions, $995; Weitek 1167/3167 coprocessor versions, $1,295.
Requires: 2MB RAM, 8.5MB free disk space, DOS 3.0 or later.
In Short: Superb graphics, a powerful programming language, and strong third-party support are *Mathematica*'s strong points, but it lacks some of the functions provided in the other packages.

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ning fast—comparable to those of *Gauss* and as much as ten times the speed of other symbolics programs. However, *Maple* is faster on some of the other numerical problems.

Mathematica's built-in language is an amalgam of C, APL, Prolog, and Lisp ideas; like the other toolbox languages, it is likely to have a steep learning curve. Its considerable power partially compensates for the relative weaknesses in the symbolics area.

The program boasts a network of third-party support, with over 50 developers working on add-ons (although only a few have actually been produced). Being less than two years old and with only three versions so far, you'd think that *Mathematica* would be playing catch-up. In fact, this program has garnered so much attention since its introduction that, at least in the eyes of those who haven't been using the competition's software on a mainframe or mini for many years, *Mathematica* defines the field.

With such a hold on the public's imagination, Wolfram Research needs only to improve the range of *Mathematica*'s built-in features and get third-party vendors interested enough to actually produce new add-on products that will fill in the gaps, thus helping *Mathmatica* to become virtually unbeatable. ■

Barry Simon, a Los Angeles-based mathematician, is a contributing editor of PC Magazine.

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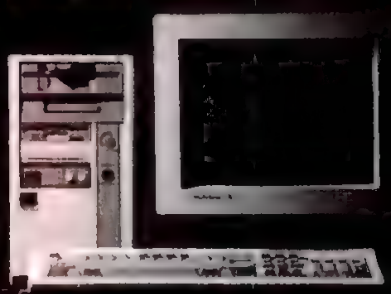

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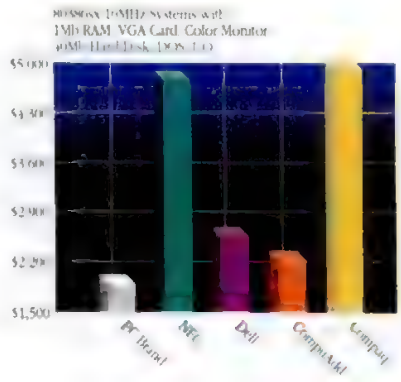

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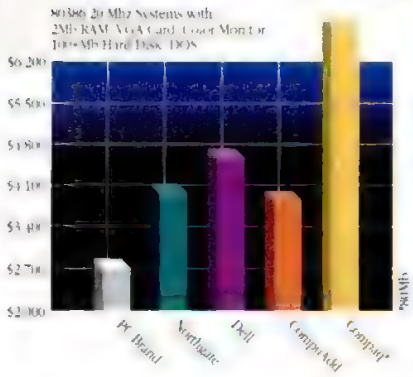

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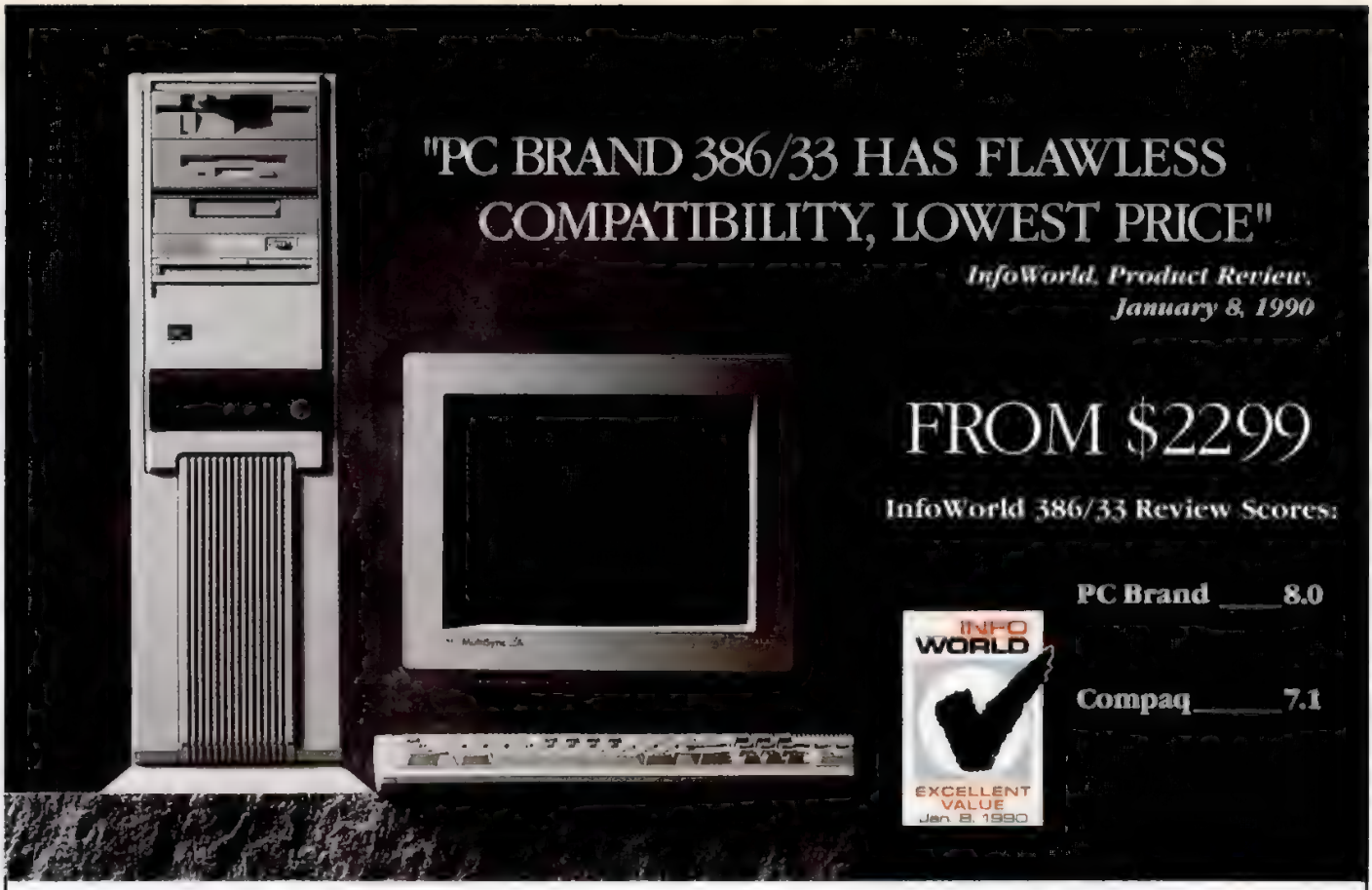
SVGA/Color	$2419	$2599	$2739	$3189

PC BRAND 386/25

with Hard Disk Drive, Monitor & Video Card

Hard Drives: Mb/Ms	40/25	66/25	100/25	200/19
No Video	$1929	$2109	$2249	$2699
Mono	$2049	$2229	$2369	$2819
VGA-Mono	$2229	$2409	$2549	$2999
VGA-Color	$2459	$2639	$2779	$3229
SVGA/Color	$2569	$2749	$2889	$3339

CIRCLE 309 ON READER SERVICE CARD



386/33 CACHE _____ $2299

33 MHz Clock, Zero Wait Operation, Norton SI 45.9 • Landmark 58.7 MHz, 1024K RAM, 1.2MB or 1.44MB Drive, 101-Keyboard, 2 Serial and 1 Parallel Ports

"Here's a price $2799... [Now $2299] Must be stripped to nothing, Right? Wrong...You don't sacrifice quality for low price either. The PC Brand machines are an efficient combination of in-house engineering and top-notch off-the-shelf Parts."

-PC Magazine, 33MHz 386 PC's, October 31, 1989

"...great value. *Period*. ...excellent price performance ratio; high quality."

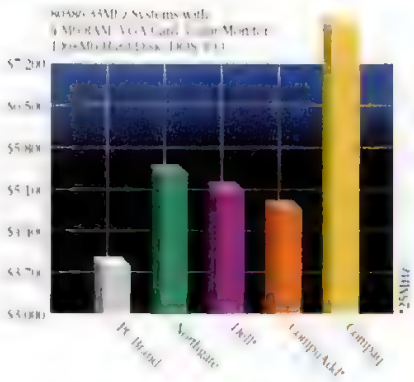
-Computer Buyers Guide, Product Review, February, 1990

Standard System Features:

- True 33 MHz INTEL 80386-33 CPU operating w/Zero Wait States Delivering up to 58.7 MHz Effective Throughput
- Intel 82385-33 Cache Processor with 32K 25NS Static RAM Standard
- 1024K RAM Standard Expandable to 16MB
- FCC Class "A", Intended for business use
- High performance 16bit VGA Cards with 1024x768 capability on all VGA systems
- 1.2MB 5.25" or 1.44MB 3.5" Diskette Drive
- 1:1 Interleaving Hard Drive Floppy Drive Controllers, 1 Mb/Second disk transfer rates on all 100Mb drives or larger
- Enhanced 101-key Click/Tactile Keyboard
- I/O Ports-2 serial,1 parallel
- High Capacity 200 Watt System Power Supply
- Real Time Clock/Calendar with 5 Year Battery
- 80387 or Weitek Co-Processor support
- Phoenix BIOS with Full MS/DOS, OS/2, XENIX, UNIX, NOVELL, 3COM compatibility
- EMS and Disk Cache in ROM
- 8 Slot motherboard design
- Medium foot print case w/6 Disk Drive bays

Options:

- Full size Tower * Case w/8 Disk Drive bays (as shown above)
- Custom configurations w/Name Brand peripherals of your choice
- Factory Installed Ram Upgrades



PC BRAND 386/33 CACHE

with Hard Disk Drive, Monitor & Video Card

Hard Drives: Mb/Ms	40/25	66/25	100/25	200/19
No Video	$2679	$2859	$2999	$3449
Mono	$2799	$2979	$3119	$3569
VGA-Mono	$2979	$3159	$3299	$3749
VGA-Color	$3209	$3389	$3529	$3979
SVGA/Color	$3319	$3499	$3639	$4089

Turn the page for Portables & Peripherals

Call 1-800-PC BRAND

(Call 1-800-722-7263) In All 50 States FAX# 1-800-722-7392

PC Brand, Inc. 954 W. Washington St., Chicago, IL 60607 Canadian Fax # 312-633-2889 Canadian Voice # 312-226-5200 We are open Mon thru Fri 8am to 6pm Central Time. MasterCard, VISA, Discover, Checks and Approved P.O.s are Accepted. Prices and specifications subject to change. **PCM 9-10**

CIRCLE 304 ON READER SERVICE CARD

The Industry's Most Flexible Casing Options

How many times did you wish that your computer were just a little smaller. How about space for another disk or tape drive? Or just one more I/O slot to add that scanner board, fax card or modem?
And remember that time when you needed just another few hours in the day to get that project done and couldn't take your system home or to a Client's?

PC Brand recognizes that many users have unique needs. The standard desktop machine is always a compromise that does't fit everyone.
To us, our Client's needs always come first, so we offer the largest, most flexible series of enclosure alternatives available in the industry today.

Slim Line

Neat, compact, attractive and versatile; our Slimline desktop case offers the ideal solution for the Executive's desk where both footprint and appearance are important, or the Entry station where space is at a premium. Available in configurations ranging from entry level Diskless 286/12 workstations up through top of the line performing 386's with over 200Mb of disk storage, this unit sacrifices little to achieve its goals of clean design and small size.

Desk Top

Unlike the conventional 'Clone' cases found in the market, our Standard full sized desk top case is the first of an entirely new generation. This case fully integrates the lessons learned in the last 5 years of PC history. Full 8 slot I/O, 6 Drive bays and a 200 Watt PS/2 style compact Power Supply result in maximum configurability across our full line of system/drive and video applications, where a desk top placement is desired.

Mini Tower*

Where your application requires more drives or I/O slot configurability than offered with our Slim Line case, but small footprint, attractive design and desk top placement are still required, our Mini Tower* Case is the solution.

Server/Multi-User Tower*

Our Server/Multi-User Tower* case has been designed for Local Area Network and other Multi Terminal applications which typically call for massive Disk storage, maximum I/O card slot usage, high total system power consumption and enhanced operational security. It's larger size, cable routing facilities, enhanced power supply, extra cooling and push button security features have all been optimized around the needs of these systems.

Rack Mount & Custom Cases

Rack mount and other custom enclosures can be configured to your specifications by our special bid desk.

*Tower is a registered trademark of NCR corporation

CIRCLE 310 ON READER SERVICE CARD

Server/Multi-User Tower*

Physical Specifications

Dimensions: 7.5"W x 25.5"H x 17.9"D

Construction: 1.4mm Heavy Gauge Zinc Plated Steel, Slide-In Top

Weight: 47.3 Lbs

Functional Specifications

I/O Slots: 8 total featuring: 8 full length 16-bit or 8-bit

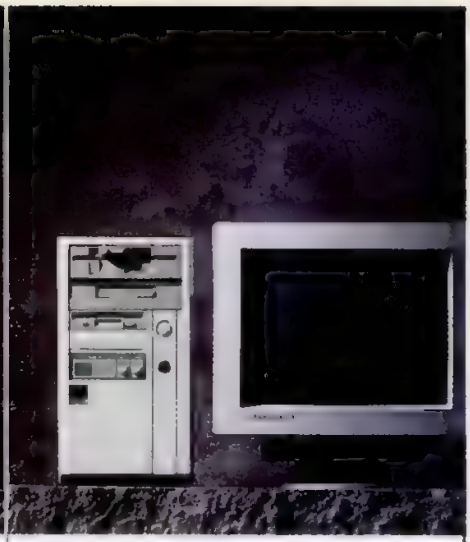
Drive Support: 6 total disk or tape drives mounted as follows: 4 Exposed 5.25" 1/2 Height 2 Internal 5.25" 1/2 Height (all bays can be used for 3.5" drives also.)

System Power: 220 Watt U/L Heavy Duty

Indicators: Turbo Speed Numeric Indicator, Hard Disk, Activity LED, Power On LED

Switches: Power *On* on front of case, Turbo Speed Change Push Button, System Reset Push Button, Keyboard Key Lock

Special Push button cover to protect against accidental activation of either turbo or reset buttons.



Slim Line

Physical Specifications

Dimensions: 17.1"W x 4.25"H x 16.8"D

Construction: 1.2mm Heavy Gauge Zinc Plated Steel, Slide-In Top

Weight: 26.5 Lbs

Functional Specifications

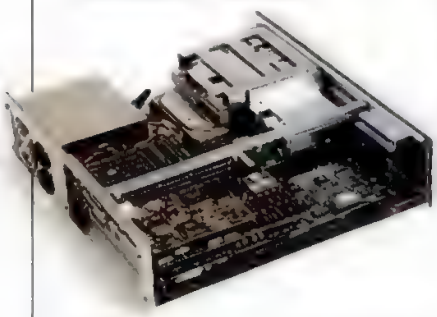
I/O Slots: 5 total mounted on 90 degree rotated adapter tree inserted into main system board 16-bit slot featuring
2 full length 16-bit
1 half length 16-bit
2 half length 8-bit

Drive Support: 3 total disk or tape drives mounted as follows:
1 Exposed 5.25" 1/2 Height
1 Internal 5.25" 1/2 Height
1 Exposed 3.5" 1/2 Height

System Power: 200 Watt U/L PS/2 Style

Indicators: Turbo Speed LED, Hard Disk Activity LED, Power On LED

Switches: Power *On* on front of case, Turbo Speed Change Push Button, System Reset Push Button



Desk Top

Physical Specifications

Dimensions: 18.9"W x 6.5"H x 15.9"D

Construction: 1.4mm Heavy Gauge Zinc Plated Steel, Slide-In Top

Weight: 40.5 Lbs

Functional Specifications

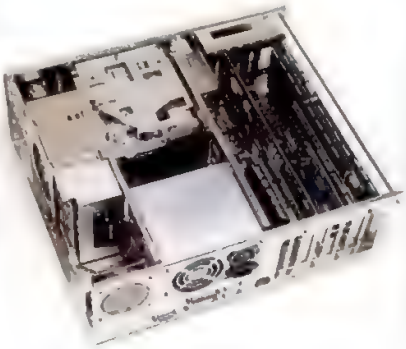
I/O Slots: 8 total featuring
8 full length 16-bit or 8-bit

Drive Support: 6 total disk or tape drives mounted as follows
2 Exposed 5.25" 1/2 Height
2 Exposed 3.5" 1/2 Height
2 Internal 5.25" 1/2 Height

System Power: 200 Watt U/L PS/2 Style

Indicators: Turbo Speed LED, Hard Disk Activity LED, Power On LED

Switches: Power *On* on front of case, Turbo Speed Change Push Button, System Reset Push Button, Keyboard Key Lock



Mini Tower

Physical Specifications

Dimensions: 7"W x 12.9"H x 15.9"D

Construction: 1.2mm Heavy Gauge Zinc Plated Steel, Slide-In Top

Weight: 25.6 Lbs

Functional Specifications

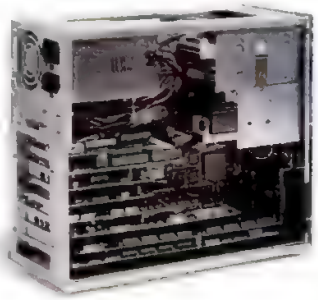
I/O Slots: 7 total featuring
7 full length 16-bit or 8-bit 1 half length 16-bit or 8-bit

Drive Support: 4 total disk or tape drives mounted as follows
2 Exposed 5.25" 1/2 Height
2 Exposed 3.5" 1/2 Height

System Power: 200 Watt U/L PS/2 Style

Indicators: Turbo Speed Numeric Indicator, Hard Disk, Activity LED, Power On LED

Switches: Power *On* on front of case, Turbo Speed Change Push Button System, Reset Push Button, Keyboard Key Lock



All photographs above feature PC Brand 386 Series motherboards configured with maximum options to demonstrate the capabilities of each specific case

Certain I/O, drive, and power cables have been removed to improve visibility of components

CIRCLE 311 ON READER SERVICE CARD

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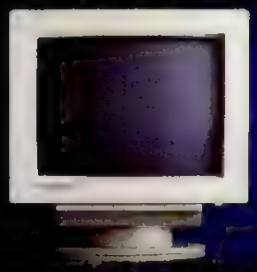
NEC Multisync 2A 14" SVGA
$479



Epson LQ 510 $319

Monitors

Cornerstone Technology
19" Dualpage Display/16 level $1950/2795
Imtek/Samsung
14" VGA Color .31DP (640x480) $369
14" VGA Color .41DP (640x480) 299
14" SVGA Color (to 1028x768) 419
Mitsubishi
1381 14" Diamond Scan (to 800x600) $499
HL6605 16" SVGA/EGA (to 1280x1024) 1195
HL6905 20" SVGA/EGA (to 1280x1024) 2095
NEC
GS-2A 14" MultiMono (to 800x600) $249
2A 14" SVGA (800x600) 479
3D 14" SVGA/EGA (1024x768) 649
4D 16" SVGA/EGA (1024x768) 1150
5D 20" SVGA/EGA (1280x1024) 2350
Panasonic
C1391 PanaSync (to 800x600) $489
M1500 15" Mono DTP with adapter 1208
M1900 19" Mono DTP with adapter 1498
Princeton Graphics
Max15 14" Mono (to 1024x768) $249
UltraSync 14" SVGA/EGA (800x600) 520
UltraSync 16" SVGA/EGA (1024x768) 879
Princeton Publishing Labs
Multiview 15" Mono DTP w/adapter $690
Relisys
9503 14" VGA Mono (640x480) $145
9513 14" VGA Color (640x480) 369
1520 15" SVGA (1024x768) 679
Seiko
1440 14" SVGA (1024x768) $599
Sony
1304 14" SVGA (to 1024x768) $689
GDM-1606 16" CADD (1280x1024) ..... Call
GDM-1953 19" CADD (1280x1024) ..... Call
Zenith
ZCM1492 VGA Flatscreen (640x480) $619

Video Cards

ATI
VGA Wonder 256K/512K $245/297
Cardinal *PC Magazine's Editors Choice*
VGA 100 8 bit 256K (800x600) $109
VGA 500 16 bit 256K (1024x768) 175
VGA 600 16 bit 512K (1024x768) 199
NEC *PC Magazine's Editors Choice*
Graphics Engine 16 (1024x768) $679
Graphics Engine 256 (1024x768) 969
Paradise
EGA Autoswitch 480 ..... $99
VGA 1024 with 256K 199
VGA 1024 with 512K 239
8514/A Plus ..... 569 VGA Upgrade 199
Video Seven
1024i VGA with 256K/512K $239/299
VRAM VGA with 512K 469

PC BRAND VGA Cards

VGA 256K (8 bit) $99
VGA 256K (16 bit) 139
VGA 512K (16 bit) 189

"an outstanding device... compared with the 15 high performance VGA cards tested in PC Magazine's July 1989 issue."

-PC Magazine, Product Review, Oct. 31, 1989

Modems

ATI
2400ETC Internal with MNP5 ..... $165
2400ETC External with MNP5 205
Hayes
1200B Internal with Smartcom $189
2400B Internal with Smartcom 249
1200 External ..... 285 2400 External 359
PC Brand (*100% Hayes Compatible*)
1200 Internal with software $49
1200 External ..... 70 2400 External 129
2400 Internal with software/MNP5 ..... 89/129

Courier HST 14,400 External $599
Courier V.32 9600 External 889
Courier HST/V.32 External 995
Courier HST 9600 Internal 579

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Complete PC
Complete Fax 4800/9600 ..... $249/399
Complete Communicator 549
Complete Portable Fax 9600 309
Intel
Connection Coprocessor $699
Quadram
4800/9600 ..... $179/495

Co-Processors

Intel
8087-1 ..... $189 8087-2 ..... $129
80287-10 ..... 229 80387-SX 309
80387-16 ..... 349 80387-20 399
80387-25 ..... 479 80387-33 639
Weitek
Abacus 20/25/33 ..... Call

Floppy Disk Drives

360K 5.25" Half Height Black $75
720K 3.5" Half Height Black 80
1.2M 5.25" Half Height Grey 85
1.44M 3.5" Half Height Grey 95
Sysgen
Bridge-File 5.25" 360K/1.2MB External $229
Bridge-File 3.5" 720K/1.44MB External 229
Bridge-File PC/AT Adapter 59

Hard Disk Drives

Compaq/Conner IDE Upgrades
40M 28ms ..... $459 100M 25ms $679
200M 19ms 1249
Iomega
B1201 20M Int. ... $765 B1441 40M Int. .. $995
B244X Dual 5.25 44M External 1995
PC2/50 NonbootableCard 169
PCZR/50 Bootable Card 230
Plus Hardcards
Hardcard 20 8 bit $539
Hardcard 40 8 bit or 16 bit 599
Hardcard 80 16 bit 695
Seagate
20M 65ms ST225 Half Height $209
20M 35ms ST125 Half Height 245
30M 35ms ST138 Half Height 310
40M 28ms ST251-1 Half Height 349
40M 24ms ST151 Half Height 419
80M 28ms ST4096 MFM 590
Add $50 for XT Kit for ST1xx, ST2xx

Tape Backups

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ST600 Int. or FT60 Ext. 60MB w/cont. $390
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VP150I 150MB Internal Novell certified 895
VP150E 150MB External Novell certified 1175
VP402 Interface Board for VP Series 115
VP409 PS/2 Interface Board for VP Series 230
Colorado Memory Systems
DJ-10 Jumbo 40/80MB Internal $249
KE-10 External Chassis Kit with Interface 139
Maynard
Maynstream 60MB Portable $889
Maynstream 150MB Portable 1395
Maynstream 2200HS 2.2GB Portable 4350

RAM/I-O/Accelerator Boards

Intel
Aboveboard Plus 512K $419
Aboveboard Plus I/O 469
Inboard 386 PC with 1M 595
Inboard 386 AT with 0K 859
PC Brand I/O Cards
AT 1P/2S/1G $49
XT 1P/1S/1G/Clock/Calendar 49

CD-ROM

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Laserdeck 2000 500MB External Kit $619
Microsoft
Bookshelf 1.0 ..... $195 Stat Pack $99
Programmer's Library 295
NEC
CDR77 Ext. ..... $555 CDR80 Int. $499
XT/AT Interface Kit 129
Clipart 3D ..... 285 Image Folio 285
Sony *Kits*
CDU510 Int. ..... $665 CDU701 Ext. $779

Plotters

CalComp
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Houston Instruments (Call for Prices)
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DMP61DL ..... DMP62 ..... DMP62DL
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MSF 400G ..... 2750 MSII Edge Feed .. 1050
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12x12 ..... $335 12x18 ..... $599

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CalComp WIZ 1000 DPI $175
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Hi-Rez C9 Mouse with Paint 99
Trackman 320 DPI Serial/Bus 99/109
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Serial with Windows 200 DPI 139
Bus Mouse with Paintbrush 105

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IB4 4 Outlet Isobar 45
LC1200 Line Conditioner 159
BC325 Battery Back-up 279
BC450Battery Back-up 349
OMNI450 or 450LAN Battery Back-up 419
BC750LAN Battery Back-up 549
OMNI1200 Battery Back-up 795

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(Numbers in Parentheses Indicate Draft/LQ CPS)

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BJ130e 15" ..... $695 LBP4 Laser $995
LBP6-III Laser 8PPM 1650

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LQ850 (330/88) 495 LQ950 (264/88) 495
LQ1010 (150/50) 439 LQ1050 (330/88) 669
LQ2550 (400/108) 899 EPL6000 6PPM 939

Hewlett Packard
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Laserjet II ..... 1720 Laserjet IID 2995
Laserjet III 8PPM 1Mb NEW! 1650

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Postscript Cart. for II or IIP 375
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Superfont Cartridge $295
1M Memory Kit 269
2M Memory Kit 549

Princeton Publishing
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NEC
P220XE (192/54) ..... $335 P5XL (400/190) $1050
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LC890XL 8PPM 4MB 4495
Silentwriter II Printers ..... Call

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ML320 (300/62) ..... $345 ML321 (300/62) $479
ML380 (180/60) 359 ML390 (270/90) 475
ML391 (270/90) 655 ML393 (450/120) 995
OkiLaser 400 4PPM 1010

Panasonic
1180 (192/38) ..... $189 1191 (360/48) $245
1124 (192/63) 299 1624 (192/63) 429
1695 (330/66) ..... 415 4420 Laser ..... Call

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Lantastic
2 Mbs Starter Kit/Adapter $419/195
Ethernet Starter Kit 575
Ethernet Adapter 279

Standard Micro
PS110 Board for PS/2 ..... $439
PC500 16 Bit for WS/Server 375/449
PC550 16 Bit Tw. Pr. for WS/Server 395/495
PC270E Twisted Pair 139
PC130 Arcnet Board 135
ARCNET passive hubs/active hubs 72/359
ARCNET Intell. hub coax/Tw. pr. 495/609

Synoptics
505UTP Transceiver $139
1000 Conc./2500 Workgroup Conc. 2575/839

Tiara
4 port hubs ..... $49 8 port hubs $285
Lancard/A 8 bit ARCNET 89
Lancard/A 16 bit ARCNET Board 249
Lancard/E 8 bit Ethernet 199
Lancard/E 16 bit Ethernet Twisted Pair 339
Lancard/E 8 bit Twisted Pair 329

Tops
Repeater ..... $125 Flashcard $195

Western Digital
Ethercard+ ..... $185 A (PS/2) $285
Ethercard+ Twisted Pair 319
Ethercard+ 16 bit 255

Xircom
Pocket ARCNET Adapter Coax or Tw. Pr. $295
Pocket Ethernet Adapter Twisted Pair 489

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Sony 5.25" 360K (box) $9
Sony 5.25" 1.2M (box) 14
Sony 3.5" 720K (box) 13
Sony 3.5" 1.44M (box) 25
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3.5" Diskette Case 11
Toner Cartridge for HP Deskjet Plus, LaserJet II and IIP ..... Call

Data Cartridges
DC2000 (ea.) . $19 DC600(ea.) .. $27
DC600XL (each) 29

Novell Networking

(Novell Authorized Sales and Support)

4 User ELS Level I $429
8 User ELS Leve II 989
Advanced Netware 1850
SFT Netware 286/Netware 386 ..... 2850/4550

Network Utilities

Brightwork Development
PS-Print ..... $415 Queue ITI $119

CC: Mail
25 User ..... $495 Expand $445
Remote ..... 235 Gateway 895

Cheyenne Software
Netback ..... $189 Monitrox $305

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Lanspace ..... $310 Lanspool $259

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Tops
NetPrint 2.0 ..... $145 Network Bundl ... $169

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4 Port/8 Port $645/795

Wyse Terminals
WY60 ..... $309 WY150 ..... $305
WY370 14" Color 859
(Call for Keyboard options)
WY50/WY85 (both w/Keyboard) 389/409

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Xenix 286 ..... $995 Xenix 386 ..... $1150

Xenix Software
Foxbase+ 386 ..... $779 Microsoft Word .. $495
Open Desktop ..... Call
VP/IX 1/3+ User 359/629
Xenix-Net 286/386 ..... 439/479
Word Perfect 4.2 569

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Autosketch Animator $239
Borland Quattro ..... 95 Quattro Pro 279
Caere Omnipage 386 2.1 619
Datastorm ProComm Plus 52
dBase IV ..... 479 Microrim R:Base 489
Delrina Perform 2.0 159
Delta Technology Direct Access 59
Deskview 386 v. 2.2 125
Fifth Generation Fastback Plus 109
Foxbase + ... 189 Harvard Graphics .. 329
Generic CADD Level 3 155
IBM Displaywrite IV 249
Lotus Freelance Plus 329
Lotus 123 r. 2.2 ..... 349 Lotus 123 r. 3.0 389
Microsoft Works ..... 99 Word 5.0 215
Norton Utilities Adv. 79
Paradox v. 3.0 ..... 445 PC Tools 5.5 79
Peachtree Acctg III/with Data Query 149/245
Pro. Write ..... 145 QEMM 5.0 65
Quicken ..... 39 Timeslips III 159
Symatec Q&A 3.0 .. 215 Timeline 3.0 379
Timeworks Publish III 125
Word Perfect 5.1 ... 249 Wordstar Pro 5.5 225
Ventura Publisher 2.0 499

Windows Software

Aldus Pagemaker $499
AMI ..... 129 AMI Pro. 319
Corel Draw 329
Microsoft Windows 286/386 ..... 69/125
Microsoft Excel 2.1 309
Microsoft Word for Windows 325
Precision Software Superbase 2 189
Precision Software Superbase 4 395
HOC Windows Express or Manager . 49
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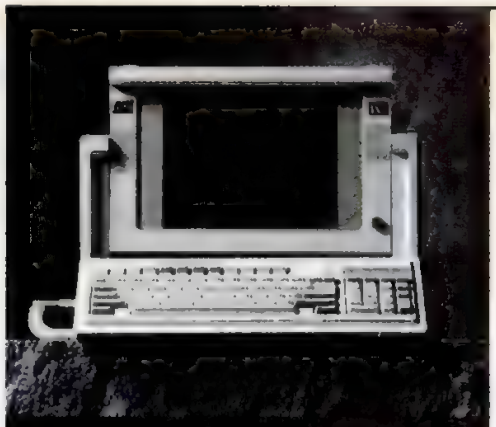

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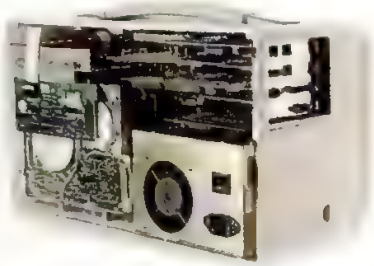

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by
Barry Simon

Lab Notes

How to Get the Most From your System's High DOS Memory

Squeezing maximum performance from your personal computer often requires you to master some bewildering topics, but few involve more arcane issues than those related to expanded and extended memory. If you have a 386-based computer (or one of a number of 286-based machines) these issues become even more complex, for it is then possible to access yet another area of memory, called *high memory*.

High memory is the 384K region between 640K and 1MB that is reserved for use by your system—for video memory, BIOS, and so on. Programs such as Quarterdeck's *QEMM* and Qualitas' *386max* manage this area of reserved memory so that you can place resident programs there, thus freeing up more conventional memory for your regular applications (see Figure 1). Recent versions of these programs, Quarterdeck's *QRAM* and Qualitas' *Move-'em*, also allow certain 286 computers to gain access to this reserved memory. This Lab Notes column focuses on what is in the DOS high memory region and how you can put it to work to make your system as efficient as possible.

A TRADITION OF CONFUSING TERMS

The traditional terminology used to refer to PC memory invites confusion. Extended memory is quite different from expanded memory. Neither type has any relation to high memory, except that high memory is the area that expanded memory uses to keep track of itself. While terse and true, it's hardly luminous.

Moreover, not only is there the high memory between 640K and 1MB; there is also another high memory. This is a 64K memory area (actually 64K minus 16 bytes) that DOS can access with most 386- and 286-based computers when they are operating in real mode. This second high memory region is directly above the 1MB boundary, and it is controlled and accessed by using Microsoft's HIMEM.SYS driver. To explain how these memory pieces fit together we must begin by clarifying these terms.

■ By understanding how to use memory managers like QEMM and 386max, you can make more room for programs within the DOS limits.

STANDARD MEMORY

Most readers are basically familiar with the Intel 8086/8088 family of central processing units (CPUs). The PC and PC-XT use an 8088 CPU, the 8-bit brother of the 16-bit 8086. For convenience in the discussion that follows I'll generally refer only to the 8086 where there is no need to distinguish between the two. On an 8086, 16 of the CPU's pins send signals that correspond to the 16 bits of actual data the CPU sends to and from the system RAM. Data by itself is meaningless, however, unless there is a way to keep track of what it is. The system bus needs to know where specific data is to go or where it will come from. To accomplish this, the CPU uses another 20 of its pins to create unique memory addresses. This allows an 8086 (or the PC's 8088) to address 2^{20} unique bytes—1MB of memory.

In the original architecture of the PC, 640K of this 1MB was reserved for DOS and applications running under it, and the area from 640K to 1MB was reserved for system use. While it is true that most of the 640K of conventional memory is almost always in use, it is also true that there are parts of the reserved system memory that the system does not use and that could be made available for other purposes. It's this available part of the 640K to 1MB address space that *QEMM* and *386max* manage, and it is this part of the memory that you will want to know more about.

It's convenient and conventional to divide the 1MB of memory into 16 sequential chunks of 64K each. These chunks, sometimes called pages, are labeled with hexadecimal digits as 0 through F; that is, 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F. (There's an old programmer's joke that hex numbering is easy if you cut off four toes.) So DOS gets regions 0-9 (10 chunks of 64K equal 640K), and the system gets the rest: regions A,B,C,D,E,F.

Each 64K chunk is sometimes further broken up into 16 regions of 4K each. These are, of course, also labelled with hex digits. Thus, for example, the A region is broken into 0 through F additional regions, A0,A1, . . . ,AF. Both *QEMM* and *386max* use these hex addresses. To complete the picture, both programs add two more digits, so that *386max* refers to the combined A6 and A7 regions as A600h-A800h. While the latest release of *QEMM* (Version 3.0) has adopted this syntax, earlier versions would designate it as A600h-A7FFh instead. I'll generally use the *386max* convention, since that is now applicable to the current *QEMM*.

EXTENDED MEMORY

Extended, expanded, and Microsoft's HIMEM are all schemes for accessing more than the standard 1MB of memory. The 80286 chip has four more address lines

than the 8086/88, which allows it to access 16 times (2^4) as many address spaces. Memory addresses above the 1MB limit are called *extended memory*. Whenever a 286 is emulating an 8088 (that is, operating in real mode), it cannot access this memory. To use extended memory, the CPU must shift into *protected mode*.

Because the 286 was designed before Intel knew what a hit the 8088 would be, its designers omitted a simple way to switch back to real mode from protected mode. Various tricks are used to make the backward switch, and—on the CPU's scale—these tricks turn out to take considerable execution time, thus degrading performance and threatening lost interrupts. For this reason it has not been possible, until recently, to run code in extended memory. Its main use in the DOS world has been to store disk-cache and print-spooler buffers.

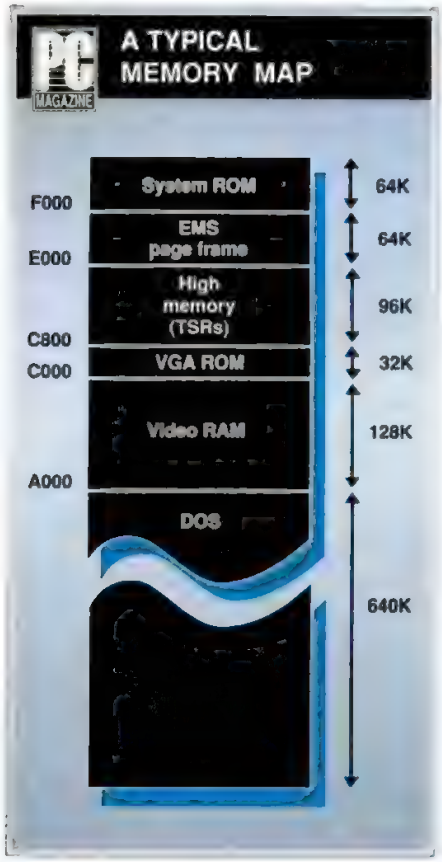

Figure 1: Of the 1MB of memory that comes standard in most systems, 640K is reserved for DOS and its applications and 384K is set aside for system use.

A DOS extender, such as that found in *Lotus 1-2-3*, Release 3 works by running code in extended memory and switching back to real mode only when a DOS service is called. While this works for an application that has full control of the machine, it doesn't work well with resident programs.

You can have up to 15MB of extended memory on a 286 machine (16MB total memory). It is physically possible for a 386 to address 4 gigabytes of memory since it does have 32 address lines (2^{32} bytes). Most 386 machines place an artificial limit of 15MB to memory capacity, however, because of the BIOS and bus connectors used.

OS/2 uses extended memory. However, because OS/2 runs in protected mode, the term "extended memory" becomes superfluous. Under OS/2 all of these memory designations go away and there is, simply, memory—whatever amount happens to be installed.

HIMEM

Microsoft did not invent HIMEM, as is usually supposed. It was used earlier by Quarterdeck's *DESQview*, though it became widely available only with the release of *Microsoft Windows* 2.10. HIMEM uses a mere 64K of available extended memory—or, to be more exact, it uses the first 64K (minus 16 bytes) of extended memory, the memory directly above 1MB. The very important thing about HIMEM is that this 64K is accessible in real mode and can be used without a DOS extender. One possible use for HIMEM is to allow DOS to locate some of itself there, thus freeing up additional memory below 640K for user programs.

HIMEM actually depends on a bug in the same way that the 286 emulates the 8086! In addition to breaking up memory into pages—16 nonoverlapping 64K chunks—the CPU thinks of memory as overlapping 64K chunks, called segments, which start every 16 bytes. Suppose the CPU tries to access one of the segments that starts very close to the top of the 1MB boundary. An 8086 will wrap around to very low memory, as shown in Figure 2.

On an 80286, however, the address actually accessed is just *above* the 1MB boundary. This provides real-mode addressabilty to the first 64K (minus 16 bytes) of extended memory. It's 16 bytes less than 64K because the last segment begins 16 bytes shy of the 1MB boundary. To overcome the emulation bug, IBM built special capabilities into the bus that force memory to wrap around, like an 8086/88, in real mode. What the HIMEM driver does is to *undo* this safeguard selectively, so that a program specially written to use that area can put code there. That is what *Microsoft Windows*, *DESQview*, *Ventura Publisher* and *Carousel* do.

EXPANDED MEMORY

Expanded memory, often called EMS (for Expanded Memory Specification) or LIM (for its originators, Lotus, Intel, and Microsoft) is a bank-switching scheme that allows the CPU to access a large amount of memory through a 64K window. EMS boards take over one 64K region of the address space above the 640K boundary. For the sake of discussion, let's use the region located at D000h-E000h, which is the default on most boards. This area is referred to as the page frame. EMS memory is logically divided into 16K chunks called pages.

These pages are different from the 64K pages in the 8086 address space although,

Figure 2: There are actually two high memory areas. The second is 64K and is directly above the 1MB boundary. DOS can access it with most 286- and 386-systems operating in real mode.

like the 64K pages, they are nonoverlapping. EMS boards have special hardware that can switch which four of these pages are accessed by the CPU when it sends a command to read from or write to memory with addresses in the page frame. By moving this window around via program commands, the CPU can access as much memory as is physically on the board, though it can do so only a small piece at a time. The LIM 4.0 specification and the earlier EEMS extended the notion by making it possible to move not only the page frame, but (with suitable hardware) other regions of the 8086 address space as well. With the appropriate hardware this kind of swapping can be used for multitasking by *DESQview* and *Windows*.

> Expanded memory is particularly useful because it uses only addresses below the 1MB boundary, so it can be used on both 8088s and 8086s.

Expanded memory is particularly useful because unlike extended memory and HIMEM, it uses only addresses below the 1MB border; hence it can be used on 8088/86 machines.

Into this mix of maps and memory comes the wondrous 386 microprocessor, which possesses some special memory-mapping features of its own. The 386 can maintain a lookup table that allows it to distinguish between logical and physical memory; it can remap what physical memory corresponds to what logical memory. An example is shadow ROM. The video ROM on most adapters is comparatively slow—much slower than the RAM in 386 machines. However, a program can copy the ROM to RAM and then adjust the lookup tables so that calls to what is logically the ROM address are actually routed to the copy in the significantly faster RAM. What programs then think is located at normal ROM addresses (logical addresses) is actually accessed at different physical RAM addresses.

The LIM 4.0 specification is the standard organizing specification for EMS memory. For access to protected memory there are actually two specifications: Microsoft's XMS (Extended Memory Specification), and VCPI (Virtual Control Program Interface). VCPI allows a program to request protected-mode resources from a protected-mode memory manager like *386max* or *QEMM*. Only because they support VCPI can protected-mode 386 programs like *Mathematica* and *Interleaf* run under these memory managers.

DOS HIGH MEMORY

Having digested all the preceding information, we can now move on to what really

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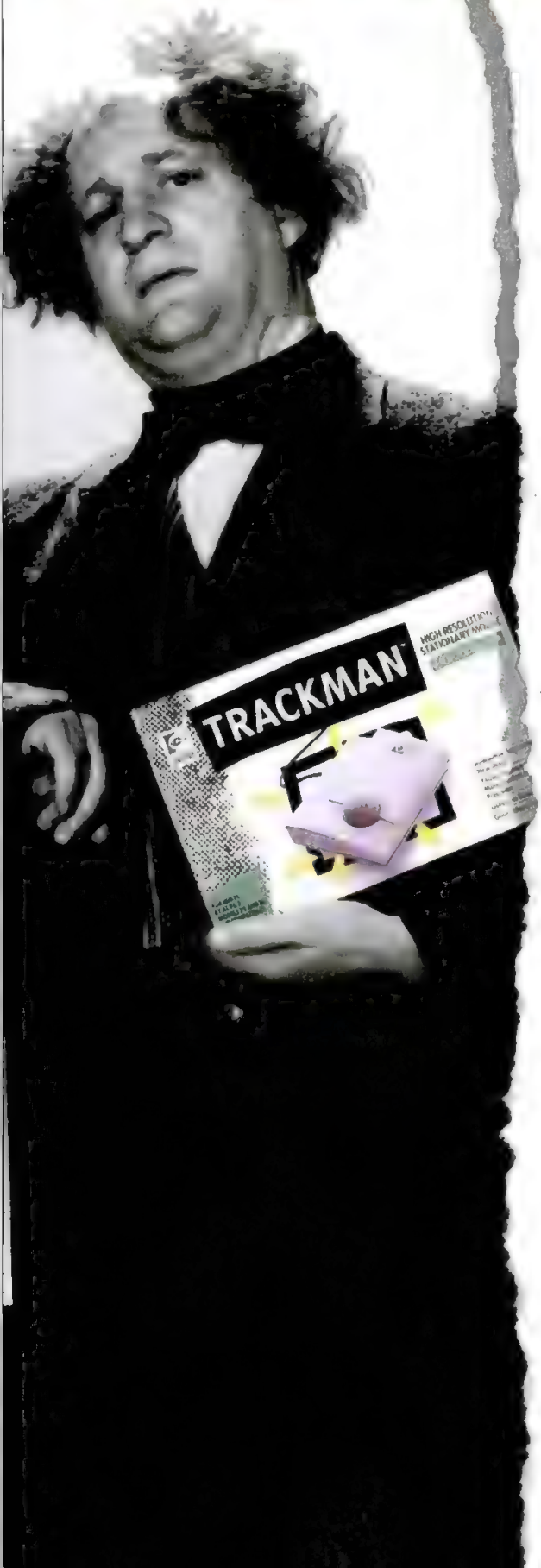

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concerns us: the actual use of high DOS memory. The area from A000h to FFFFh was reserved by IBM for system hardware. On many machines, however, not all of this area is used. For example, if you have the right system BIOS, on a nongraphics monochrome system you might be using as little as 36K of the reserved 384K, though on an IBM PS/2 with an 8514/A video adapter and a network card you could be using over 300K of it. Anything not in use is "wasted" address space into which the 386 memory managers can map real memory. We'll look at specific uses shortly, but first you'll need to know what your own system is leaving idle.

You'd think that smart memory managers like *QEMM* and *386max* could figure out all the allocated and unallocated memory areas for you automatically. They do try, but there are too many variables associated with nonstandard hardware—and we nearly all have *some* nonstandard hardware—for them to do the whole job without some experimenting on your part.

So, grab a sheet of paper and a pencil and create three columns: In Use, Surely Free, and Maybe Free. Next, make six rows—one row for each of the regions A through F. Now we can try to figure out what address spaces we can give over to programs. If using a piece of paper and a pencil is too much, you can, of course, fire up your favorite spreadsheet.

ALLOCATING HIGH DOS MEMORY

The A and B regions are reserved for video memory, but for most people at least some part of them is unused. The original monochrome adapter had 4K on it to accommodate the 4000 bytes needed to describe a text screen (25 rows by 80 columns by 2 attributes). This memory begins at B000h and goes almost to B100h. Unfortunately, depending on the particular system BIOS you have, the code for simple functions such as the CLS command can affect more than just the 4K memory area from B000h-B100h. My Northgate's AMI BIOS uses only this 4K, but my in-boarded AT effectively uses B000h to B200h, and some Compaqs use B000h to B400h. Hence, you'll need to experiment if you have a monochrome adapter.

The CGA used 16K, from B800h to BC00h. While this makes the region from BC00h to C000h free, in principle, on CGAs, you use it at your peril since some software assumes that this unused video memory is available. Such programs will happily overwrite whatever your memory manager puts there. Hercules cards in graphics mode use the entire B region. EGA and VGA use the B800h to C000h region for text mode and those graphics modes that emulate a CGA, and the entire A region for high-resolution graphics. It may surprise you that cards that come with 256K (as EGAs usually do) or even 512K (as some superVGAs have) can get by using only the address space in the A region—after all it is only 64K. The cards utilize a bank-switching scheme similar to what EMS uses. All of this memory is RAM that is hard-wired to the video output and is therefore unmappable, as shown in Figure 3. Figure 4 depicts the overall situation for the A and B regions.

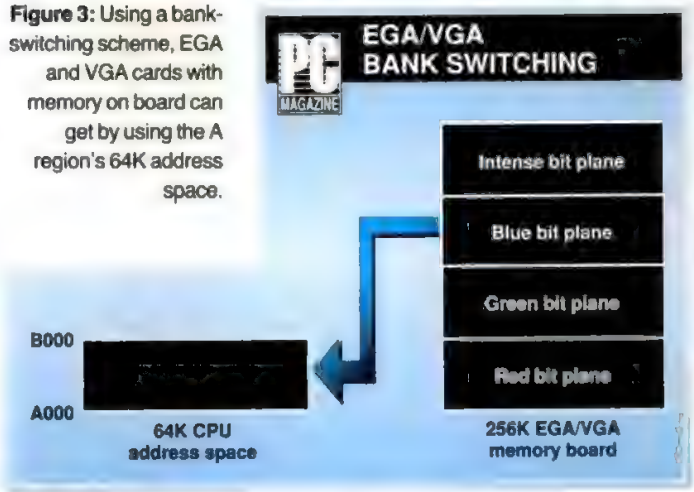

Figure 3: Using a bank-switching scheme, EGA and VGA cards with memory on board can get by using the A region's 64K address space.

The other standard region is the F region. This is where the system ROM is placed. However, not all systems use the full 64K allotment, and not all of this 64K is needed after you boot. For example, on systems with recent versions of the AMI BIOS, the memory from F000h-F800h is used by the setup/diagnostics program, which can be invoked during boot-up. Since this range is not used after startup, I can have a memory manager use the address space for something else.

On an original IBM AT, F600h-FC00h is used by ROM BASIC, so it is unnecessary if you're willing to sacrifice the use of BASICA or to use GW BASIC instead. If you are adventurous, you can experiment using some of this address space on your machine. To be on the safe side, back up your hard disk before you start and, of course, remember to prepare a boot diskette. If the memory you try to assign elsewhere turns out to be system ROM that is used, you'll almost surely crash the system while the memory manager is loading.

In ATs, the E region is not available because it is hard-wired to an empty ROM socket. This doesn't matter for the 386 versions of *QEMM* and *386max*, but it is relevant for the new 286 programs. PS/2s come standard with 128K of system ROM that takes up the E and F address regions. On most other machines, the E region is totally free. But, just to keep you guessing, some VGAs locate their ROM at E000h. Furthermore, some Zenith computers put RAM at C000h to C800h and E000h to E800h. This requires a command-line switch for the memory managers to tell them that there is RAM in these areas.

Regions C and D are a hodgepodge at best. On EGA and VGA systems the video ROM is usually at the bottom of the C region; on IBM cards and many EGA clones it's located at C000h to C400h, but on some other VGAs the C000h to C800h region is used. The Video7, Paradise, and Compaq VGAs use ROM from C000h to C600h. But the Video7 and Paradise cards also use RAM in the C600h to C800h region. Older versions of *QEMM* and *386max* used these areas by default, and your system would crash if you switched into certain video modes. This became such a technical support problem that the most recent versions of these memory managers will not use C600h to C800h by default if they find ROM at C000h to C600h. If you have a Compaq VGA, check whether your memory manager is using this area and if it isn't, place a

```
USE=C600-C800
```

statement with *386max*, or an

```
I=C600-C800
```

statement with *QEMM*. Network cards and SCSI or ESDI ROM usually squeeze somewhere else into the C through D address range.

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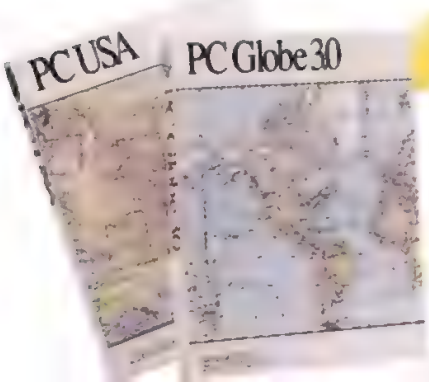

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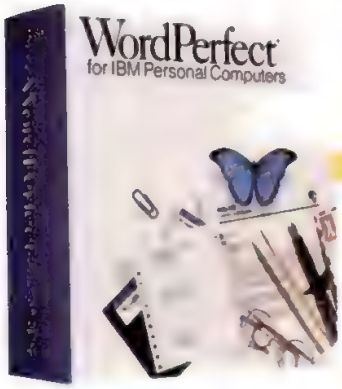

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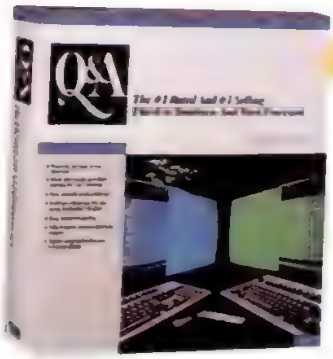

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using my own system as an example. I have a Video 7 VRAM, which uses the full A-region memory, the B800h to C000h region for video RAM, and C000h to C800h for video ROM and special RAM. I also have a monochrome card installed, and it uses B000h to B100h. By default, both managers will avoid the entire B000h to B800h region if they find a monochrome card, so I've got to tell them specifically to use the B100h to B800h areas.

I also have SCSI ROM that can be placed in various locations by manipulating its DIP switches. I've set it to locate itself at C800h to CC00h to prevent fragmenting my high RAM. I've got nothing else located in high DOS memory except for system ROM. Since the latter is the AMI type, I can free up the area from F000h to F800h. Consequently, the *QEMM* line I use is:

```
DEVICE=C:\QEMM.SYS RAM ROM I=B100-
B7FF I=F000-F7FF FRAME=CC00
```

The RAM and ROM keywords tell *QEMM* to do its best job of filling empty address space with logical RAM and to map all ROM to fast memory. The two I commands tell it to use those regions. The frame command concerns the *Ventura* "gotcha" I'll discuss later. When I run *386max*, I use

```
DEVICE=C:\386MAX.SYS USE=B100-
B800 USE=F000-F800 FRAME=CC00
```

The ROM and RAM keywords aren't needed with *386max* because they are the default. With older versions of *QEMM* you need to add

```
EXCLUDE=C600-C7FF
```

and for older versions of *386max* add

```
RAM=C600-C800
```

KNOWN PROBLEMS

There are a number of "gotchas" and cautions that you should be aware of. Aristocad makes a number of programs that give you a large virtual page in *Ventura Publisher*, *Microsoft Windows* or *Excel* (*SoftKicker*, *SoftKicker Plus*, and *ExcelMore*). These all use the EGA and VGA in a special mode that accesses the full A000h to C000h region, including the B000h to B800h area that would normally be free on EGA/VGA-only systems. Thus, you lose 32K of TSR space and you must be sure that your memory manager does not use it.

There is a bug in *Ventura* 2.0's *Professional Edition* that causes it to produce frequent error messages if your EMS page frame starts above E000h. By default, the memory managers will put the page frame as high up as they can. So, if you can make use of the F000h to F800h region and you have the *Professional Edition*, you'll want to move the page frame as low as possible. This will avoid the conflict and also prevent the fragmenting of your high memory. That's the reason for the FRAME =CC00 commands in the examples.

Finally, there is a general problem (not related to these memory managers) with the high DOS memory area and 16-bit VGA cards. The ISA bus specifications force the bus to run each 128K section of RAM either entirely in 8-bit or entirely in 16-bit mode. So the entire A and B regions must be one type, C and D of a possibly different type, and E and F of the same type.

Video 7 makes VGA cards with RAM and ROM capable of 16-bit operation; Paradise comes with 16-bit ROM. When the cards initialize, they look for 8-bit memory and shift to that mode if necessary. Thus, on my system, my VRAM sees an 8-bit monochrome adapter at B000h to B100h and shifts all its video RAM to 8-bit, and it sees the SCSI adapter ROM at C800h to CC00h and shifts the ROM to 8-bit.

The loss of ROM is irrelevant since my 386 memory manager maps it to 32-bit RAM. This is possible because the remapping is at the logical level and the bus specification only cares about physical memory.

The slower video speed resulting from 8-bit operation is unfortunate, however, and can cause problems. What you need to look out for is that some cards—especially certain network adapters—initialize their on-board RAM only *after* your system boots. A problem can thus develop if this new RAM is 8-bit and is located in an area that a video card has forced to 16-bit. The solution is not a pleasant one: you will need to use DIP switches on the video card to force 8-bit operation.

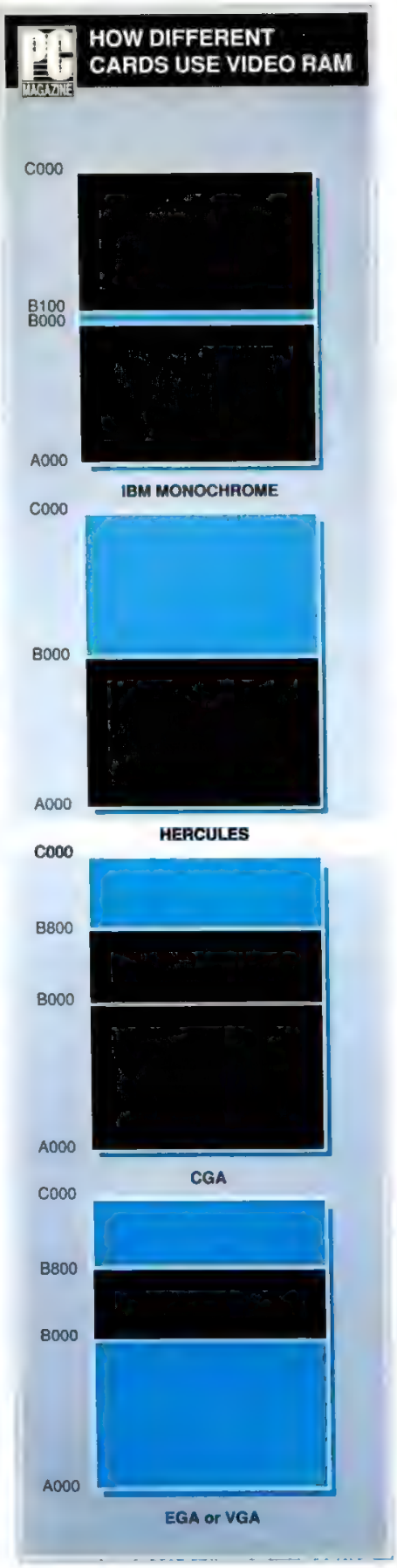

Figure 4: Above 1MB, the A and B regions are set aside for video memory. Many video cards don't use these areas entirely, but video memory still may not be available for other purposes.

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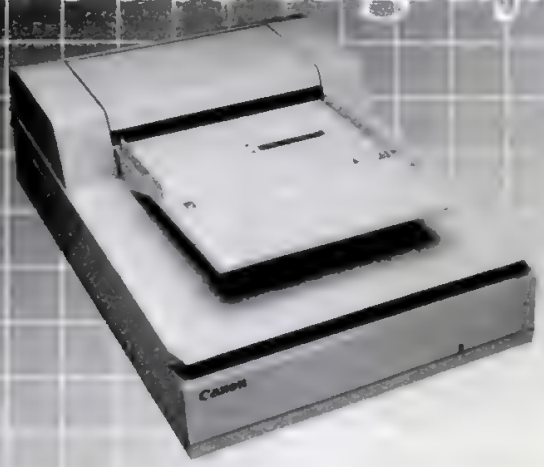

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Lab Notes

Once you have figured out which areas of memory can be used for TSRs, fitting them requires more work. You need to worry about how much memory each TSR uses when loaded, as well as the possibility that a TSR may require additional memory *while* loading. For example, *SideKick Plus* can take as little as 70K after loading, but it requires more than 200K while loading. This makes it impossible to load into high memory. Figuring out all of the combinations can be a daunting task, but fortunately both *QEMM* and *386max* come to the rescue with recently added modes that automate the operation.

> Although setting up programs like QEMM takes effort, it can save many kilobytes of precious RAM.

Setting up these programs optimally can require a lot of effort, but keep in mind that you will only need to do it once, and the gain can be tens of kilobytes of precious RAM space. In a few years, when most of us are using OS/2, we'll look back and laugh at the notion that tens of kilobytes of RAM were so precious, but within the 640K barrier they are.

The next step is for you to take the plunge and begin taking advantage of these programs that allow you to access the high DOS area. Keep in mind that in addition to managing high DOS memory the programs offered by Quarterdeck and Qualitas also manage extended memory and emulate expanded memory, allowing you to configure your entire system for optimal performance. This explanation of the various pieces in the memory puzzle—and the close look we have taken at the high DOS area—will hopefully make that optimization process easier. All that's left is for you to get to it. ■

Barry Simon is a contributing editor of PC Magazine.

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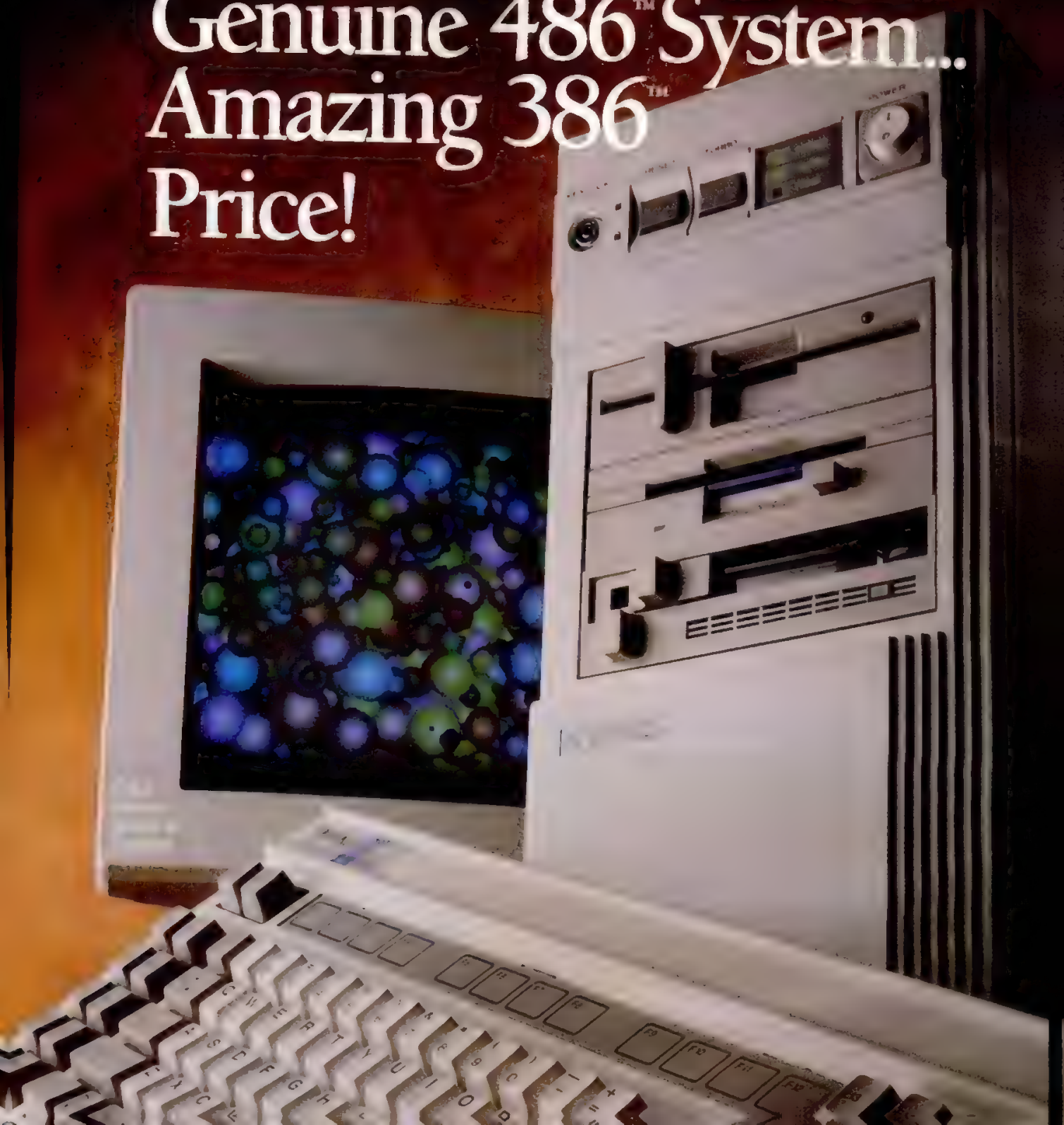

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by
Michael J. Mefford

Utilities

COMPUTE.COM: The Command-Line Calculator

It maddens me that I can't do simple arithmetic right at the DOS prompt. *Webster's* tells us that a computer is "an automatic electronic machine for performing simple and complex calculations." We all know that PCs can handle the complex stuff. But they're not very handy when all you want to do is add up a few numbers or evaluate a simple expression such as (2+2)*8.

COMPUTE.COM makes the easy stuff easy. How much will that new well pump, lining and holding tank cost you? Suppose the pump is $397, the holding tank is $500, the pipe is $3.50 per foot, your well is 170 feet deep, and the labor is an additional $225. On the command line you simply enter

```
COMPUTE 397+500+(3.50*170)+225
```

The result (sigh) is $1,717 down the drain.

There are other calculator programs you could use, of course. *SideKick*'s pop-up calculator is probably the most popular, and Douglas Boling's CALC (*PC Magazine*, March 29, 1988) is a favorite programmer's pop-up calculator. These are memory-resident programs, however, and so eat up precious RAM. And while you can pop them up from within other programs, you have to load them in advance and perform their operations as if you were actually using a calculator.

If you just want to calculate from the DOS command line (shelling out of your applications if need be), and if getting the answer is more important than simulating the look of a calculator on-screen, then COMPUTE.COM is all you need. Burdening your system with a TSR pop-up is overkill.

You can download copies of COMPUTE.COM, its assembly language source code (COMPUTE.ASM), and the BASIC program (COMPUTE.BAS) that will generate COMPUTE.COM when you run it once in BASIC from PC MagNet. Instructions for downloading are in the sidebar "COMPUTE by Modem."

In recent months, the source code for the Utilities column hasn't appeared in the magazine so that we can publish more columns that provide tips to help you work smarter. However, in this issue we've made room for the complete assembler and BASIC listings. We'll print future programs whenever we can make room.

> ■ Memory-resident calculator programs are overkill if you just need a quick total. But with COMPUTE, you can perform simple calculations right at the DOS prompt.

USING COMPUTE

COMPUTE is a command-line calculator that performs five functions: add, subtract, multiply, divide, and modulo. Its syntax is simply

```
COMPUTE arithmetic expression
```

The *arithmetic expression* can include any or all of five function operator characters: +, -, *, /, and %. Note, however, that the % symbol (extracted from the C language) is the modulo operator and does *not* stand for percent.

The modulo operator returns the remainder of an integer division. For example, the operation

```
COMPUTE 8 % 5
```

returns a remainder of 3. If the result of a modulo operation is 0, then you know that the dividend is an exact multiple of the divisor.

Most programming languages will not accept a real number as a modulo argument, because the result would not make much sense. But some languages do attempt to return a meaningful result by turning numbers with fractional parts into whole numbers when the modulo operator is used. Turbo Pascal, for example, truncates the decimal portion of a number before it performs division. COMPUTE rounds off the two operands before the division. If the operands, as in the example above, are already integers, then the rounding obviously has no effect.

All of COMPUTE's computations are in decimal: the characters 0 through 9 are the only digits recognized by the program. COMPUTE is not, after all, a programmer's calculator designed to understand hex, binary, and octal. You can, however, include commas to delimit long numbers. The commas will help you visualize numbers, and they are simply ignored by COMPUTE.

You can also use pairs of parentheses and square brackets in your expressions. For example, you can enter

```
COMPUTE 5*[(6/5)+6]-2
```

COMPUTE stores the result of its last calculation on-disk, right within COMPUTE.COM itself. This memory feature is useful for storing intermediate results of calculations. You can recall the last result and use it in the next computation by simply entering x in your expression. If, for

example, you enter

```
COMPUTE 4+5
```

the result presented on the screen is, of course, 9. If you then enter

```
COMPUTE 5*x
```

the program replies, "Result is 45," and 45 then becomes the new x value. COMPUTE will let you know what value is currently stored if you enter

```
COMPUTE x
```

COMPUTE follows the standard arithmetic operator precedence, as listed in Figure 1. You can override the normal order of precedence by enclosing an operation in parentheses or brackets. For example, multiply operations are normally completed before addition operations so that

```
COMPUTE 4+5*2
```

results in 14, not 18.

To force the addition first, just add the parentheses, thus:

```
COMPUTE (4+5)*2
```

This will return 18. No harm is done by adding extra pairs of parentheses just to make sure the expression is evaluated as you intended. But you must make sure that all parentheses and brackets are balanced.

HOW COMPUTE EVALUATES EQUATIONS

Priority	Operator	Definition
1st	+,-	Unary (sign)
2nd	*,/,%	Multiplication, division, modulo
3rd	+,-	Addition, subtraction

Figure 1: COMPUTE.COM performs operations on the same level of precedence as they are encountered, working from left to right. Unary operations have the highest precedence. An example of a unary operator is the minus sign in front of the 6 in the expression 8 * −6 = −48. Addition and subtraction are performed last. Expressions within parentheses or brackets are performed before any adjacent operations.

COMPUTE uses fixed-point arithmetic for all its calculations. The precision of numbers is 20 digits on either side of the decimal point. That means the largest number supported is 999999999999999-99999.99999999999999999999.

A limited amount of error checking is built into COMPUTE. If the program comes across something it doesn't understand, it will point out where in the equation the error occurred. COMPUTE will catch an invalid character, division by zero, mismatched parentheses or brackets, and overflow when a number exceeds 20 integer digits. The program will not catch a gross error, however, such as

```
COMPUTE 6-*+7
```

STORING THE LAST RESULT

Since COMPUTE.COM stores the result of its last calculation within itself, the file COMPUTE.COM has to be opened and written to. You probably won't even notice this brief disk access unless you keep the program on a floppy disk. DOS 3.*x* or later makes it easy for COMPUTE to find COMPUTE.COM by passing the complete path to the current application in the environment. This means that you can rename COMPUTE.COM as, say, C.COM (thus saving keystrokes) and COMPUTE will find itself.

With DOS 2.*x*, however, the directory for COMPUTE.COM must either be the current directory or be included in the DOS PATH=statement. Also, with DOS 2.*x* COMPUTE will not be able to find COMPUTE.COM if you change its name.

PARSING AND NUMBER FORMATS

COMPUTE uses a recursion algorithm to parse the expression to be evaluated. This algorithm is discussed in the sidebar "Understanding COMPUTE's Recursion Algorithm." Because of space limitations, unfortunately, we cannot publish this and two other sidebars mentioned in this column. However, all three will be available from PC MagNet.

There are several established formats for storing "real" numbers; that is, numbers that can contain a fractional part. Floating-point formats are the most commonly used. Three such floating-point types are 6-byte single-precision reals, 8-byte double-precision reals, and 10-byte BCDs (binary-coded decimals).

Floating-point numbers have a mantissa, a sign, and an exponent. The mantissa holds the digits, and the exponent "floats" the decimal point into its proper position. The sign, of course, indicates whether the number is positive or negative.

Evaluating a floating-point number involves multiplying the mantissa by the number base to the power of the exponent. Single- and double-precision mantissas are in binary or base 2. A number such as 0.50 decimal is represented by

$$1.0 * 2^{-1}$$

Here, the 1.0 is the mantissa, the 2 is the base of the mantissa, and the -1 is the exponent. Remember that a negative exponent means the reciprocal of the power. Therefore, the value of 2^{-1} is .5 (or one half). So the value is 1.0 times one half, or 0.50. The negative exponent shifts the decimal one place to the left.

By floating the point, the computer can represent a range of numbers that runs from very large to very small. For example, of the 48 bits of 6-byte reals, 8 bits are used for the exponent. The range therefore is 2^{-128} to 2^{+127}, which, in base 10 notation, is $1.0 * 10^{-39}$ to $1.0 * 10^{+38}$.

The 39 bits allocated to the mantissa allow for only 11 decimal digits of precision. Although the 6-byte real-number format can thus represent a number as large as 38 decimal digits, its precision is only 11 decimal digits.

Getting a wide range of values from only 6 bytes is the strength of floating-point numbers. Very large or very small numbers can be represented without using lots of memory. Also, since binary floats (that is, floating-point numbers) are in base 2, the same base upon which computers operate, calculations are very efficient.

Some decimal fractions can be expressed exactly in binary floating point. For example, .50 decimal is .10 in binary. Other decimal fractions, however, cannot. For example, .60 in decimal must be approximated by .10011 . . . in binary.

As you see, converting numbers to binary floating point can result in round-off errors. Normally, if the number is not too large or small, the precision limit hides the error, which is not apparent when the number is converted to decimal for output.

In financial applications, however, the integer part can climb into the billions, the fractions can be minute, and accuracy is required down to the penny. Ultimately, the precision of 6-byte reals is just not sufficient for such applications. 8-byte reals

COMPUTE BY MODEM

The programs published in *PC Magazine* are available by modem from PC MagNet.

To join PC MagNet, set your communications software for either 300 or 1,200 bits per second, 7 data bits, even parity, 1 stop bit, and full duplex. To find the number nearest your dialing exchange, dial (800) 346-3247. When the modem connects, press Enter. At the HOST NAME prompt, enter PHONES. Follow the menus and note the number closest to you.

After you have found the phone number nearest you, hang up and redial using that number. When you connect with PC MagNet, press Ctrl-C. At the HOST NAME prompt, enter CIS. At the USER ID prompt, enter 177000,5000. Enter PC*MAGNET at the PASSWORD prompt and Z10D9010 at the ENTER AGREEMENT NUMBER prompt. For Customer Service, call (800) 848-8990; outside the United States, call (614) 457-8650.

To download COMPUTE.COM and its assembly or BASIC listing, log on to PC MagNet. Enter GO UTILITIES or choose PC MAGAZINE UTILITIES from the top menu, then DIRECT UTILITY DOWNLOAD from the next menu. Enter the filename, then select the file you want to download from those presented. Answer yes (Y) to DO YOU WISH TO DOWNLOAD? Press Enter to see the transfer protocols. Choose a protocol and download the file.

You don't have to be a member of CompuServe to access PC MagNet. It costs $12.80 an hour for 1,200/2,400-bps service and $6.30 for 300-bps, via MasterCard, VISA, or American Express. These programs can be copied but are copyrighted and are made available only for noncommercial use. You may make copies for others as long as no charge is involved, but making copies for any commercial purpose is prohibited.

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COMPUTE Commands

Michael J. Mefford May 29, 1990 (Utilities)

Purpose: A calculator with addition, subtraction, multiplication, division, and modulo functions that work directly from the DOS command-line prompt.

Format: `COMPUTE arithmetic expression`

Remarks: COMPUTE accepts decimal numbers only, and the operators in its *arithmetic expression* are +,-,*,/, and %. Note that the % symbol does not stand for percent, but rather designates the modulo operator, which returns the remainder of an integer division. (Example: COMPUTE 8 % 5 returns the value 3, since 5 goes into 8 once with a remainder of 3.) When working on real numbers with a fractional part, the modulo operator in COMPUTE rounds off the operands before the division.

The standard order of precedence for arithmetic operations is followed by default. Multiple levels of parentheses and square brackets are supported, however, so the order in which calculations are made can be modified. Thus, while COMPUTE 4 + 5 * 2 returns the value 14, the command COMPUTE (4 + 5) * 2 returns 18.

COMPUTE stores its last calculated result within its own .COM file. This number, designated x, can be recovered and used in the next calculation, whose result becomes the new x. The value of the currently stored x can be seen by entering the command COMPUTE x, and x can be used as an operand, as in COMPUTE x + 5.

The program can handle decimal numbers up to 20 digits on either side of the decimal point. Rounding errors are precluded by using a binary coded decimal (BCD) format. Under DOS 3.*x* and later, COMPUTE can be renamed to a shorter name to save keystrokes. Under DOS 2.*x*, however, the program cannot be renamed and must be stored either in the current directory or in one designated in a PATH= statement.

COMPUTE.COM can be downloaded directly from PC MagNet, as can its source code, COMPUTE.ASM and COMPUTE.BAS (a BASIC program that will generate the .COM file when run.) To create COMPUTE.COM from COMPUTE.ASM requires a macro assembler (IBM or Microsoft, Version 2 or later) and the following commands:

MASM COMPUTE;
LINK COMPUTE;
EXE2BIN COMPUTE COMPUTE.COM

COMPUTE.ASM 1 of 5

```
;-----------------------------------------------------------------------;
;  COMPUTE • PC Magazine • Michael J. Mefford                           ;
;  Command line five function math calculator.                          ;
;-----------------------------------------------------------------------;

_TEXT           SEGMENT PUBLIC 'CODE'
                ASSUME  CS:_TEXT,DS:_TEXT,ES:_TEXT,SS:_TEXT
                ORG     100H
START:          JMP     MAIN


;               DATA AREA
;               ---------
SIGNATURE       DB      CR,SPACE,SPACE,SPACE,CR,LF

COPYRIGHT       DB      "COMPUTE 1.0 (C) 1990 Siff Communications Co.",CR,LF
PROGRAMMER      DB      "PC Magazine ",BOX," Michael J. Mefford",CR,LF,LF,"$"
SYNTAX          DB      "Syntax: COMPUTE arithmetic expression",CR,LF
                DB      "Operators supported are + - * / % ( ) [ ] 0-9 x",CR,LF
                DB      "Note: % = modulo, remainder of integer division.",CR,LF
                DB      "       x = answer of last compute."
CRLFLF          DB      LF
CRLF            DB      CR,LF
                DB      "$",CTRL_Z

CR              EQU     13
LF              EQU     10
CTRL_Z          EQU     26
SPACE           EQU     32
BOX             EQU     254
COMMA           EQU     ","

INTEGER_PRECISION       =       20
DECIMAL_PRECISION       =       20
PRECISION       =       INTEGER_PRECISION + DECIMAL_PRECISION

NUMBER          STRUC
SIGN            DB      0
INTEGER         DB      INTEGER_PRECISION DUP (0)
DECIMAL         DB      DECIMAL_PRECISION DUP (0)
NUMBER          ENDS

SIZE_MANTISSA   =       SIZE INTEGER + SIZE DECIMAL
SIZE_DIVIDEND   =       SIZE_MANTISSA + SIZE DECIMAL + 1

OPERAND         DW      INITIAL_VALUE
OPERATORS       DB      "+-"
UNARY_PREFIXES  LABEL   BYTE
PRECEDENCE      DB      "*/%"
PRECEDENCE_CNT  =       $ - PRECEDENCE
OPERATOR_CNT    =       $ - OPERATORS
                DB      "([",0
PREFIXES_CNT    =       $ - UNARY_PREFIXES

LAST_CHAR       DB      0

PAREN_CNT       DW      0
PAREN_TYPE      DB      50 DUP (0)
WORKSPACE       DB      2 * SIZE_MANTISSA DUP (?)
WORKSPACE_END   EQU     $ - 1
                DB      ?                       ;Dividend overflow.
DIVIDEND        DB      SIZE_DIVIDEND DUP (?)
ANSWER          DB      SIZE_NUMBER DUP (0)

DECIMAL_PLACES  DW      0                       ;Significant decimal digits.
SAVE_SIGN       DB      ?
MODULO_FLAG     DB      0                       ; =1 if modulo division.

COMPUTE         DB      "COMPUTE.COM",0
COMPUTE_LEN     EQU     $ - COMPUTE
PATH            DB      "PATH="
PATH_LEN        EQU     $ - PATH
NOT_FOUND       DB      CR,LF,"Could not save answer in Compute.com",CR,LF
                DB      "Compute.com must be in current directory",CR,LF
                DB      "or in DOS PATH= directory.",CR,LF,"$"
RESULT_MSG      DB      "Result is $"
UNRECOGNIZED    DB      "Unrecognized character$"
MISSING_PAREN   DB      "Missing parenthesis or bracket$"
UNMATCHED       DB      "Miss-matched parenthesis with bracket$"
ZERO_DIVIDE     DB      "Divide by zero$"
OVERFLOW        DB      "Overflow$"
LOGICAL         DB      "Logic error$"
MEMORY          DB      "Requires 18K of memory$"
ERROR1          DB      "Error ",CR,LF,"$"
ERROR2          DB      " Error$",CR,LF,"$"


;               CODE AREA
;               ---------
MAIN            PROC    NEAR
                CLD                             ;Strings forward.
                MOV     DX,OFFSET SIGNATURE     ;Announce ourselves.
                CALL    PRINT_STRING

                MOV     BX,18 / 16 * 1024       ;Minimum of 18K required.
                MOV     AH,4AH                  ;Request via DOS.
                INT     21H
                MOV     DX,OFFSET MEMORY
                JC      ERROR_EXIT              ;Exit with message if not enough.

                MOV     SP,16 * 1024 - 2        ;Else, setup stack at end of seg.

                MOV     SI,81H                  ;Point to command line.
                XOR     AX,AX                   ;No characters yet.
                XOR     DX,DX                   ;Not unary.
                CALL    PARSE                   ;Parse command line.
                CALL    PARSE_DELIMIT           ;See if reached end.
                MOV     DX,OFFSET LOGICAL       ;If not, logical error.
                JNC     ERROR_EXIT

                CMP     OPERAND,OFFSET INITIAL_VALUE
                JNZ     CK_PARENS
                MOV     DX,OFFSET SYNTAX        ;Did we get a value.
                CALL    PRINT_STRING            ;If not, print syntax and exit.
                JMP     SHORT ERROR_END

CK_PARENS:      MOV     DX,OFFSET MISSING_PAREN
                CMP     PAREN_CNT,0             ;Did we match all parenthesis
                JNE     ERROR_EXIT              ; and brackets?

                CALL    RESULT                  ;Every thing seems OK so
                                                ; display result.
EXIT:           MOV     AX,4C00H                ;Exit with ErrorLevel=0
                INT     21H
MAIN            ENDP

;-----------------------------------------------;
ERROR_EXIT:     PUSH    DX                      ;Save error message.
                MOV     DX,OFFSET SYNTAX        ;Display syntax.
                CALL    PRINT_STRING
                POP     DX
                CALL    PRINT_STRING            ;Display error.
                MOV     DX,OFFSET CRLFLF
                CALL    PRINT_STRING
                MOV     BX,SI                   ;Current command line pointer.
                MOV     SI,81H                  ;Point at start of command line.
                CLD                             ;Make strings are forward.

NEXT_LINE:      MOV     CX,79                   ;1 less than 80 char. display.
NEXT_ERROR:     LODSB
                CMP     AL,CR                   ;End of command line?
                JZ      PRINT_POINTER
                CALL    PRINT_CHAR              ;If no, print character.
                CMP     SI,BX                   ;Pointing to error position?
                JE      PRINT_POINTER           ;If yes, done here.
                LOOP    NEXT_ERROR              ;Else, continue.
                MOV     DX,OFFSET CRLF          ;Filled on line; new line.
                CALL    PRINT_STRING
                JMP     NEXT_LINE

PRINT_POINTER:  MOV     DX,OFFSET CRLF          ;New line.
                CALL    PRINT_STRING
                SUB     CX,79                   ;Calculate chars. on line above.
                NEG     CX
                MOV     BX,OFFSET ERROR1        ;Assume left side of display.
                CMP     CX,40
                JB      LEFT_ARROW
                SUB     CX,6
                JMP     SHORT NEXT_SPACE
LEFT_ARROW:     MOV     BX,OFFSET ERROR2

NEXT_SPACE:     MOV     AL,SPACE                ;Pad with spaces over to error.
                CALL    PRINT_CHAR
                LOOP    NEXT_SPACE
                MOV     DX,BX                   ;Display "Error ^".
                CALL    PRINT_STRING

ERROR_END:      MOV     AX,4C01H                ;Exit with ErrorLevel = 1.
                INT     21H

;-----------------------------------------------;
; Recursive parsing routine.                    ;
;-----------------------------------------------;
PARSE:          PUSH    BP                      ;Preserve stack index.
                PUSH    DX                      ;Unary flag.
                PUSH    AX                      ;Operator.
                MOV     BP,SP                   ;Point to local vars.
NEXT_PARSE:     CALL    PARSE_DELIMIT           ;Parse white space.
                JNC     GET_CHAR                ;If command line end, exit.
                JMP     PARSE_END

GET_CHAR:       LODSB                           ;Else, get the character.
                MOV     DI,OFFSET OPERATORS     ;Is it a function operator?
                MOV     CX,OPERATOR_CNT
                REPNZ   SCASB
                JNZ     CK_NUM                  ;If no, check if number.

                XOR     DL,DL                   ;Assume not unary.
                CMP     AL,"+"                  ;Is it plus or minus?
                JZ      CK_UNARY
                CMP     AL,"-"
                JNZ     GET_OPERAND2            ;If no, not unary.
CK_UNARY:       PUSH    AX
                MOV     AL,LAST_CHAR            ;Else, does previous char
                MOV     DI,OFFSET UNARY_PREFIXES  ; suggest unary?
                MOV     CX,PREFIXES_CNT
                REPNZ   SCASB
                POP     AX
                JNZ     GET_OPERAND2
                INC     DL                      ;If yes, it's unary.

GET_OPERAND2:   PUSH    WORD PTR LAST_CHAR      ;Save last char.
                MOV     LAST_CHAR,AL            ;Store current char.
                PUSH    OPERAND                 ;Save operand pointer.
                CALL    PARSE                   ;Get second operand.
                POP     BX                      ;First operand.
                POP     CX                      ;Last character.
                MOV     DH,AL                   ;Save operator.
                MOV     DI,OPERAND              ;Second operand.
                MOV     AL,[DI]                 ;Get signs.
                MOV     AH,[BX]
                CMP     DH,"*"                  ;Check which operator.
                JZ      DO_MULT
                CMP     DH,"/"
                JZ      DO_DIV
                CMP     DH,"%"
                JZ      DO_MOD

                                                ;Must be plus or minus.
                OR      DL,DL                   ;Was it unary.
                JZ      DO_ADD                  ;If no, add operands.
                MOV     AL,CL                   ;Else, was last character
                CALL    CK_PRECEDENCE           ; "*", "/" or "%" ?
                JNZ     NEXT_PARSE              ;If no, just continue parsing.
                JMP     PARSE_END               ;Else, return second operand.
```

COMPUTE.ASM: The source code for COMPUTE, a utility that lets you perform calculations at the DOS prompt. Since it is not a TSR, COMPUTE does not remain in memory taking up precious RAM.

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```
DO_ADD:         CALL    ADD_IT                  ;Add operands.
                MOV     AL,LAST_CHAR
                CMP     AL,")"                  ;Is this an equantity?
                JZ      PARSE_DONE              ;Is yes, return it.
                CMP     AL,"]"
                JZ      PARSE_DONE
                JMP     NEXT_PARSE              ;Else, continue parsing.

DO_MULT:        CALL    MULTIPLY
                JMP     NEXT_PARSE

DO_DIV:         CALL    DIVIDE
                JMP     NEXT_PARSE

DO_MOD:         CALL    MODULO
                JMP     NEXT_PARSE

PARSE_DONE:     JMP     PARSE_END               ;Lilly pad for return.

CK_NUM:         MOV     LAST_CHAR,AL            ;Store current character.
                CMP     AL,"Y"                  ;Is it "answer" character?
                JZ      DO_ANS
                CMP     AL,"X"
                JNZ     CK_DIGIT
DO_ANS:         PUSH    SI
                MOV     SI,OFFSET ANSWER        ;If yes copy answer to operand.
                ADD     OPERAND,SIZE NUMBER     ;Point to next operand storage.
                MOV     DI,OPERAND
                PUSH    DI
                MOV     CX,SIZE NUMBER
                REP     MOVSB
                POP     DI
                MOV     AL,[BP]                 ;Get sign
                CMP     AL,"-"
                JZ      ANS_SIGN
                XOR     AL,AL                   ; and store.
ANS_SIGN:       XOR     [DI],AL
                POP     SI
                JMP     SHORT CK_UNARY_NUM      ;Check if return or not.

CK_DIGIT:       CMP     AL,"."                  ;Is char a num char?
                JZ      DO_NUM
                CMP     AL,"0"
                JB      CK_PAREN
                CMP     AL,"9"
                JA      CK_PAREN
DO_NUM:         DEC     SI                      ;If yes, point to it.
                ADD     OPERAND,SIZE NUMBER     ;Point to next operand storage.
                CALL    GET_NUMBER              ;Get the number.
CK_UNARY_NUM:   CMP     BYTE PTR [BP + 2],1     ;Is this a unary number?
                JZ      PARSE_END               ;If yes, return the number.
                MOV     AL,[BP]                 ;Get operator.
                CALL    CK_PRECEDENCE           ;If high precedence, go do it.
                JZ      PARSE_END
                JMP     NEXT_PARSE              ;Else, continue parsing.

CK_PAREN:       MOV     AH,")"
                CMP     AL,"("                  ;Is it an open parenthesis
                JZ      FOUND_PAREN             ; or bracket?
                CMP     AL,AH
                JZ      CK_OPEN
                MOV     AH,"]"
                CMP     AL,"["
                JZ      FOUND_PAREN
                CMP     AL,AH                   ;Was it a close parenthesis or
                MOV     DX,OFFSET UNRECOGNIZED  ; or bracket?
                JNZ     PARSE_ERROR             ;If no, must be invalid char.

CK_OPEN:        DEC     PAREN_CNT               ;If close, decrement level.
                MOV     DX,OFFSET MISSING_PAREN ;If overflow then had no
                JC      PARSE_ERROR             ; open.
                MOV     BX,PAREN_CNT            ;Retrieve level index
                MOV     PAREN_TYPE[BX],AH       ; and store close type.
                JMP     SHORT PARSE_END         ;Return results.

FOUND_PAREN:    PUSH    PAREN_CNT               ;Save level index.
                INC     PAREN_CNT               ;Next level.
                XOR     DX,DX                   ;Not unary flag.
                CALL    PARSE                   ;Parse the equantity.
                POP     BX                      ;Retrieve level.
                CMP     AH,PAREN_TYPE[BX]       ;Did we close with matching
                MOV     DX,OFFSET UNMATCHED     ; parenthesis or bracket?
                JNZ     PARSE_ERROR
                MOV     AL,[BP]                 ;Retrieve, prefix operator.
                CALL    CK_PRECEDENCE           ;Was it priority operator?
                JZ      PARSE_END               ;If yes, return value.
                CMP     AL,"-"                  ;Else store sign.
                JNZ     PAREN_END
                MOV     BX,OPERAND
                XOR     [BX],AL
PAREN_END:      JMP     NEXT_PARSE              ;And parse next.

PARSE_END:      POP     AX
                POP     DX
                POP     BP
                RET

PARSE_ERROR:    JMP     ERROR_EXIT
                RET


;-----------------------------------------------------------------;
; INPUT: SI -> string                                             ;
; OUTPUT SI -> first non-white space and CY=0 or SI -> CR and CY=1. ;
;-----------------------------------------------------------------;
PARSE_DELIMIT:  LODSB                           ;Get a byte.
                CMP     AL,CR
                JZ      STRING_END
                CMP     AL,SPACE                ;Is it a space char or below?
                JBE     PARSE_DELIMIT
                DEC     SI                      ;Else, adjust pointer to
                CLC
                RET                             ; string start.

STRING_END:     DEC     SI
                STC
                RET
```

```
;-----------------------------------------------------------------;
CK_PRECEDENCE:  MOV     DI,OFFSET PRECEDENCE
                MOV     CX,PRECEDENCE_CNT
                REPNZ   SCASB
                RET

;-----------------------------------------------------------------;
GET_NUMBER:     MOV     DI,OFFSET WORKSPACE     ;Store integer temporarily
                MOV     CX,SIZE INTEGER + 1     ; so can store right justified.
NEXT_INTEGER:   LODSB
                CMP     AL,COMMA                ;Ignore commas.
                JZ      NEXT_INTEGER
                CMP     AL,"."                  ;Decimal point; end of integer.
                JZ      STORE_INTEGER

GET_NUM2:       SUB     AL,"0"
                JC      INTEGER_END
                CMP     AL,9
                JA      INTEGER_END
                STOSB                           ;Store the number.
                LOOP    NEXT_INTEGER
                MOV     DX,OFFSET OVERFLOW      ;If got here, number too big.
                JMP     ERROR_EXIT
INTEGER_END:    DEC     SI
STORE_INTEGER:  PUSH    SI                      ;Save command line pointer.
                MOV     SI,DI
                DEC     SI                      ;End of workspace.
                PUSHF
                STD
                MOV     DI,OPERAND
                ADD     DI,SIZE INTEGER

                MOV     DX,CX
                DEC     DX                      ;Zero pad count.

                NEG     CX
                ADD     CX,SIZE INTEGER + 1
                JCXZ    PAD_INTEGER
                REP     MOVSB                   ;Store integer part in operand.

PAD_INTEGER:    MOV     CX,DX
                JCXZ    INTEGER_DONE
                XOR     AL,AL
                REP     STOSB                   ;Pad balance of integer with 0.
INTEGER_DONE:   MOV     AL,[BP]                 ;Get sign
                CMP     AL,"-"
                JZ      INT_SIGN
                XOR     AL,AL                   ; and store.
INT_SIGN:       STOSB
                POPF


DO_DECIMAL:     POP     SI                      ;Restore command line pointer.
                MOV     DI,OPERAND
                ADD     DI,SIZE SIGN + SIZE INTEGER   ;Decimal operand storage.
                MOV     CX,SIZE DECIMAL + 1           ;Left justified.
                XOR     DX,DX                   ;Decimal counter.
NEXT_DECIMAL:   LODSB
                SUB     AL,"0"
                JC      DECIMAL_END
                CMP     AL,9
                JA      DECIMAL_END
                STOSB
                INC     DX                      ;Increment decimal count.
                LOOP    NEXT_DECIMAL
                MOV     DX,OFFSET OVERFLOW      ;If got here, number too big.
                JMP     ERROR_EXIT

DECIMAL_END:    DEC     SI                      ;Adjust command line pointer.
                CMP     DX,DECIMAL_PLACES       ;Store significant decimal
                JBE     PAD_DECIMAL             ; places.
                MOV     DECIMAL_PLACES,DX

PAD_DECIMAL:    DEC     CX                      ;Pad balance with zeros.
                JCXZ    DECIMAL_DONE
                XOR     AL,AL
                REP     STOSB
DECIMAL_DONE:   RET

;-----------------------------------------------------------------;
; INPUT:  BX -> 1st and AH=sign; DI -> 2nd and AL=sign.
; OUTPUT: Result stored in DI.

ADD_IT:         PUSHF
                PUSH    SI
                STD                             ;Add or subtract right to left.
                MOV     SAVE_SIGN,0             ;Assume sign positive.

                MOV     DX,BX                   ;Save operand 2 pointer.
                MOV     CX,SIZE_MANTISSA        ;Point to end of operands.
                ADD     DI,CX
                ADD     BX,CX
                MOV     SI,BX

                CMP     AL,AH                   ;If both plus or minus, then
                JZ      ADD_SIGN                ; go ahead and add, else subtract
                CMP     AL,"-"                  ;If first operand
                JZ      SUB_IT                  ; negative and second positive
                XCHG    DI,SI                   ; swap operands before subtract.
                MOV     OPERAND,DX

SUB_IT:         MOV     BX,DI                   ;Save destination operand.
                CLC                             ;Start with no carry.
NEXT_SUB:       LODSB                           ;Get operand1
                SBB     AL,[DI]                 ;Subtract operand2 and the carry.
                AAS                             ;ASCII adjust after subtraction.
                STOSB                           ;Store it.
                LOOP    NEXT_SUB                ;Subtract next byte.
                MOV     AL,0                    ;If no carry, then positive.
                JNC     STORE_SIGN

                MOV     DI,BX                   ;Else negative so negate by
                CLC                             ; subtracting result from zero.
                MOV     CX,SIZE_MANTISSA
NEXT_NEGATE:    MOV     AL,CH                   ;Zero.
                SBB     AL,[DI]                 ;Subtract the byte.
                AAS                             ;ASCII adjust after subtraction.
```

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```
                STOSB                           ;Store it.
                LOOP    NEXT_NEGATE
                MOV     AL,"-"                  ;Store negative sign.
                JMP     SHORT STORE_SIGN

;               Add procedure.
;-----------------------------------------------;
ADD_SIGN:       MOV     SAVE_SIGN,AL            ;Either 2 +'s or 2 -'s; save it.
                CLC                             ;Start with no carry.
NEXT_ADD:       LODSB
                ADC     AL,[DI]                 ;Add operand two and carry.
                AAA                             ;ASCII adjust.
                STOSB
                LOOP    NEXT_ADD
                JC      ADD_ERROR               ;If carry out of number, overflow
                MOV     AL,SAVE_SIGN            ;Else, store sign.

STORE_SIGN:     STOSB
                POP     SI
                POPF
                RET

ADD_ERROR:      MOV     DX,OFFSET OVERFLOW
                POP     SI
                JMP     ERROR_EXIT

;-----------------------------------------------;
; INPUT:  BX -> 1st and AH=sign; DI -> 2nd and AL=sign.
; OUTPUT: Result stored in DI.

MULTIPLY:       PUSH    BP
                PUSHF
                PUSH    SI
                XOR     DL,DL                   ;Assume plus result.
                CMP     AL,AH                   ;Signs the same?
                JZ      MULT_SIGN               ;If yes, assumed right.
                MOV     DL,"-"                  ;Else, negative.
MULT_SIGN:      MOV     SAVE_SIGN,DL

                STD                             ;Right to left.
                ADD     DI,SIZE_MANTISSA        ;Point to end of numbers.
                ADD     BX,SIZE_MANTISSA
                MOV     BP,DI                   ;Save destination.

                MOV     DI,OFFSET WORKSPACE_END
                MOV     DX,DI
                XOR     AX,AX                   ;Zero out scratch pad area.
                MOV     CX,SIZE WORKSPACE
                REP     STOSB

                MOV     DI,DX                   ;Point to workspace.
                MOV     CX,SIZE_MANTISSA        ;Number of digits to multiply.

NEXT_MULT:      PUSH    DI                      ;Save current product place.
                MOV     AL,[BX]                 ;Current multiplier digit zero?
                OR      AL,AL
                JZ      LOOP_MULT               ;If yes, no need to multiply.

                PUSH    CX                      ;Else, save multiplier counter.
                MOV     CX,SIZE_MANTISSA        ;Size of multiplicand size.
                MOV     DL,AL                   ;Multiplier.
                MOV     SI,BP                   ;Multiplicand pointer.
                XOR     DH,DH                   ;No carry yet.

NEXT_MULT2:     LODSB
                MUL     DL                      ;Multiply them.
                AAM                             ;Adjust BCD multiplication.
                ADD     AL,[DI]                 ;Accumulate as we go.
                AAA                             ;ASCII adjust.
                ADD     AL,DH                   ;Add the carry.
                AAA                             ;ASCII adjust.
                STOSB                           ;And store.
                MOV     DH,AH                   ;Save the carry.
                LOOP    NEXT_MULT2
                MOV     [DI],AH                 ;Store the carry.
                POP     DI                      ;Multiply by all digits.

LOOP_MULT:      POP     DI
                DEC     BX                      ;Next multiplier.
                DEC     DI                      ;Next product.
                LOOP    NEXT_MULT

                MOV     DI,OFFSET WORKSPACE_END - SIZE DECIMAL + 1
                MOV     CX,SIZE_MANTISSA
                CALL    ROUND                   ;Round up product.

                MOV     SI,OFFSET WORKSPACE_END - SIZE DECIMAL
                MOV     DI,BP                   ;Place decimal in product
                MOV     CX,SIZE_MANTISSA        ; by storing in destination.
                REP     MOVSB
                MOV     AL,SAVE_SIGN            ;Add the sign.
                STOSB

                MOV     CX,SIZE INTEGER         ;Check for overflow.
NEXT_OVER:      LODSB
                OR      AL,AL
                JNZ     MULT_ERROR
                LOOP    NEXT_OVER

                POP     SI
                POPF
                POP     BP
                RET

MULT_ERROR:     MOV     DX,OFFSET OVERFLOW
                POP     SI
                JMP     ERROR_EXIT

;-----------------------------------------------;
; INPUT:  BX -> 1st and AH=sign; DI -> 2nd and AL=sign.
; OUTPUT: Result stored in DI.

DIVIDE:         PUSH    BP
                PUSHF
                PUSH    SI
                XOR     DL,DL                   ;Assume plus result.
                CMP     AL,AH                   ;Signs the same?
                JZ      DIV_SIGN                ;Is yes, assumed right.
                MOV     DL,"-"                  ;Else, negative.
DIV_SIGN:       MOV     SAVE_SIGN,DL

                MOV     BP,DI                   ;BP -> divisor.
                INC     BP                      ;Bump past sign.
                MOV     DI,OFFSET WORKSPACE     ;Quotient scratch pad.
                XOR     AL,AL
                MOV     CX,SIZE_DIVIDEND
                REP     STOSB                   ;Zero out quotient to start.

                MOV     DI,OFFSET DIVIDEND - 1  ;Move dividend to scratch pad.
                STOSB                           ;Zero in overflow byte.
                MOV     SI,BX                   ;Dividend.
                INC     SI                      ;Bump past sign.
                MOV     CX,SIZE_MANTISSA
                REP     MOVSB
                MOV     CX,SIZE_DIVIDEND - SIZE_MANTISSA
                REP     STOSB                   ;Zero out dividend underflow.

                MOV     DI,BP                   ;Look for zero divisor.
                MOV     CX,SIZE_MANTISSA
                REPZ    SCASB
                JNZ     DIVISOR_SIZE
                MOV     DX,OFFSET ZERO_DIVIDE   ;Can't divide by zero.
                POP     SI                      ;Command line pointer.
                JMP     ERROR_EXIT

DIVISOR_SIZE:   MOV     DI,OFFSET WORKSPACE     ;Quotient.
                ADD     DI,CX                   ;Point to first quotient storage.
                ADD     BP,SIZE_MANTISSA - 1
                SUB     BP,CX                   ;First non-zero divisor digit.
                INC     CX                      ;DH = subtraction counter.
                MOV     DX,CX                   ;DL = significant divisor digits.
                MOV     SI,OFFSET DIVIDEND
                MOV     CX,SIZE_DIVIDEND + 1
                SUB     CX,DX                   ;Number of times to divide.

NEXT_DIVIDE:    CMP     MODULO_FLAG,1           ;Is this a modulo division?
                JNZ     NO_MODULO
                CMP     DI,OFFSET WORKSPACE + SIZE_MANTISSA
                JAE     DIVIDE_END              ;If yes, divide integer only.

NO_MODULO:      PUSH    CX                      ;Division count.
                PUSH    DI                      ;Quotient.
                MOV     BX,SI                   ;Save dividend pointer.
                XOR     DH,DH                   ;Initialize sub counter to zero.

NEXT_DIVIDE2:   CMP     BYTE PTR [SI - 1],0     ;Overflow in remainder?
                JNZ     SUB_DIVISOR             ;If yes, divisor fits.
                MOV     CL,DL                   ;Divisor length.
                XOR     CH,CH                   ;Zero high half.
                MOV     DI,BP                   ;Divisor.
NEXT_DIV:       CMPSB                           ;Does it fit in remainder?
                JA      SUB_DIVISOR             ;If yes, subtract.
                JB      DIV_TOO_BIG             ;If no, save subtraction count.
                LOOP    NEXT_DIV

SUB_DIVISOR:    INC     DH                      ;Sub counter.
                MOV     SI,BP                   ;Divisor position.
                MOV     DI,BX                   ;Dividend position.
                MOV     CL,DL                   ;Significant divisor digits.
                XOR     CH,CH                   ;Zero in high half.
                DEC     CX                      ;Adjust for a moment.
                ADD     SI,CX                   ;Point to current position.
                ADD     DI,CX
                INC     CX

                STD                             ;Subtract right to left.
                CLC                             ;Start with no carry.
NEXT_DIV_SUB:   LODSB
                MOV     AH,AL                   ;Divisor digit.
                MOV     AL,[DI]                 ;Remainder digit.
                SBB     AL,AH                   ;Subtract.
                AAS                             ;ASCII adjust.  (BCD)
                STOSB                           ;Store in dividend.
                LOOP    NEXT_DIV_SUB
                SBB     BYTE PTR [DI],0         ;Subtract the carry, if any.

                CLD                             ;Back to forward.
                MOV     SI,BX
                JMP     NEXT_DIVIDE2            ;Next divisor.

DIV_TOO_BIG:    MOV     SI,BX                   ;Next dividend.
                POP     DI
                POP     CX
                MOV     AL,DH                   ;Store quotient.
                STOSB
                INC     SI
                LOOP    NEXT_DIVIDE

                MOV     DI,OFFSET WORKSPACE + SIZE_DIVIDEND - 1
                MOV     CX,SIZE_MANTISSA
                STD
                CALL    ROUND                   ;Round quotient.
                JC      DIVIDE_ERROR

                MOV     CX,SIZE MANTISSA
                MOV     SI,OFFSET WORKSPACE + SIZE_DIVIDEND - 2
                MOV     DI,OPERAND              ;Store quotient in operand.
                ADD     DI,CX
                REP     MOVSB
                MOV     AL,SAVE_SIGN            ;Add the sign.
                STOSB

                MOV     CX,SIZE DECIMAL         ;Check for overflow.
NEXT_OVER2:     LODSB
                OR      AL,AL
                JNZ     [illegible]
                LOOP    NEXT_OVER2

DIVIDE_END:     POP     SI
                POPF
                POP     BP
                RET

DIVIDE_ERROR:   MOV     DX,OFFSET OVERFLOW
```

COMPUTE.ASM

```
                POP     SI
                JMP     ERROR_EXIT

;-----------------------------------------------;
; INPUT:  BX -> 1st and AH=sign; DI -> 2nd and AL=sign.
; OUTPUT: Result stored in DI.

MODULO:         PUSH    AX                      ;Save sign of dividend.
                PUSH    DI                      ;Divisor pointer.
                ADD     DI,SIZE INTEGER + 1
                MOV     CX,SIZE INTEGER
                STD
                CALL    ROUND                   ;Round divisor.
                JC      MODULO_ERROR
                POP     DI
                PUSH    DI
                CALL    MAKE_INTEGER            ;Truncate to integer.

                MOV     DI,BX
                ADD     DI,SIZE INTEGER + 1
                MOV     CX,SIZE INTEGER
                CALL    ROUND                   ;Round dividend.
                JC      MODULO_ERROR
                MOV     DI,BX
                CALL    MAKE_INTEGER            ;Truncate to integer.

                POP     DI
                MOV     MODULO_FLAG,1           ;Do modulo division.
                CLD
                CALL    DIVIDE
                MOV     MODULO_FLAG,0
                MOV     DI,OPERAND
                POP     AX                      ;Sign of dividend.
                MOV     AL,AH
                STOSB                           ;Store it.
                PUSH    SI
                MOV     SI,OFFSET DIVIDEND      ;Dividend has remainder.
                MOV     CX,SIZE_MANTISSA
                REP     MOVSB                   ;Store it in operand.
                POP     SI
                RET

MODULO_ERROR:   MOV     DX,OFFSET OVERFLOW
                JMP     ERROR_EXIT

;-----------------------------------------------;
; INPUT: DI -> Start of mantissa.

MAKE_INTEGER:   PUSHF
                CLD
                ADD     DI,SIZE INTEGER + 1
                MOV     CX,SIZE DECIMAL
                XOR     AL,AL
                REP     STOSB
                POPF
                RET

;-----------------------------------------------;
; INPUT:  DI -> End of mantissa + 1; Direction flag reversed.
;         CX = number of bytes to round.
; OUTPUT: CY=1 if overflow.

ROUND:          CMP     BYTE PTR [DI],5         ; 5 or greater?
                JB      ROUND_DONE              ;If no, done here.
                DEC     DI                      ;Else, move left one digit.
                STC                             ;Start with carry.
NEXT_ROUND:     MOV     AL,[DI]
                ADC     AL,0                    ;Add carry.
                AAA                             ;ASCII adjust.
                STOSB
                JNC     ROUND_END               ;If no carry, done.
                LOOP    NEXT_ROUND
                JMP     SHORT ROUND_END
ROUND_DONE:     CLC                             ;Return overflow.
ROUND_END:      RET

;-----------------------------------------------;
RESULT:         MOV     DX,OFFSET RESULT_MSG    ;Display "Result is ".
                CALL    PRINT_STRING
                MOV     SI,OPERAND              ;Point to result.
                LODSB
                OR      AL,AL                   ;Print sign if negative.
                JZ      PRINT_INTEGER
                CALL    PRINT_CHAR

PRINT_INTEGER:  XOR     DH,DH                   ;Non-zero digit flag.
                MOV     BL,3                    ;Comma every third digit.
                MOV     CX,INTEGER_PRECISION
                JMP     SHORT NEXT_INT2         ;Skip prefacing comma.

NEXT_INT:       OR      DH,DH                   ;Non-zero digit yet?
                JZ      NEXT_INT2               ;If no, skip.
                MOV     AX,CX                   ;Is position MOD 3 = 0?
                DIV     BL
                OR      AH,AH
                JNZ     NEXT_INT2               ;If no, no comma.
                MOV     AL,","                  ;Else, delimiting comma.
                CALL    PRINT_CHAR

NEXT_INT2:      LODSB
                OR      AL,AL                   ;Is digit zero?
                JNZ     PRINT_INT               ;If no, print it.
                OR      DH,DH                   ;Else, non-zero digit yet?
                JZ      LOOP_INTEGER            ;If no, skip.
PRINT_INT:      OR      DH,AL
                CALL    PRINT_NUMBER
LOOP_INTEGER:   LOOP    NEXT_INT

                PUSH    SI                      ;Save pointer.
                MOV     CX,DECIMAL_PRECISION    ;Count the significant decimal
                MOV     BX,CX                   ; places.
                INC     BX
NEXT_FRACTION:  LODSB
                OR      AL,AL
                JZ      LOOP_FRACTION
                MOV     BX,CX                   ;If non-zero, save count.
LOOP_FRACTION:  LOOP    NEXT_FRACTION
                POP     SI                      ;Restore pointer.
                NEG     BX                      ;Get count of significant.
                ADD     BX,DECIMAL_PRECISION + 1
                MOV     CX,DECIMAL_PLACES       ;Use the larger of significant
                CMP     CX,BX                   ; digits; number entered or
                JAE     DO_FRACTION             ; result.
                MOV     CX,BX

DO_FRACTION:    JCXZ    CK_NULL                 ;If no significant, done here.
                OR      DH,DH                   ;Else, was there a non-zero
                JNZ     PRINT_DECIMAL           ; integer?
                XOR     AL,AL                   ;If no, preface with zero.
                CALL    PRINT_NUMBER
PRINT_DECIMAL:  MOV     AL,"."                  ;Display delimiting decimal.
                CALL    PRINT_CHAR

                XOR     BL,BL                   ;Comma counter.
NEXT_DEC:       CMP     BL,3
                JNZ     NEXT_DEC2
                MOV     AL,","
                CALL    PRINT_CHAR
                XOR     BL,BL
NEXT_DEC2:      LODSB                           ;Display decimal digits.
                CALL    PRINT_NUMBER
                INC     BL
LOOP_DEC:       LOOP    NEXT_DEC
                JMP     SHORT RESULT_END

CK_NULL:        OR      DH,DH                   ;Was there a non-zero integer?
                JNZ     RESULT_END              ;If yes, done here.
                XOR     AL,AL                   ;Else, display solitary, zero.
                CALL    PRINT_NUMBER
RESULT_END:     MOV     DX,OFFSET CRLF          ;New line.
                CALL    PRINT_STRING


;-----------------------------------------------;
SAVE_ANSWER:    MOV     SI,OPERAND              ;Copy operand to answer.
                MOV     DI,OFFSET ANSWER
                MOV     CX,SIZE NUMBER
                REP     MOVSB

                MOV     AH,30H                  ;Get DOS version.
                INT     21H
                CMP     AL,3                    ;Filename in environment
                JB      TRY_CURRENT             ; not support before DOS 3.x.

                MOV     DS,DS:[2CH]             ;Segment of environment.
                XOR     SI,SI
FIND_ENV_END:   LODSB                           ;Find end of environment.
                OR      AL,AL
                JNZ     FIND_ENV_END
                LODSB
                OR      AL,AL
                JNZ     FIND_ENV_END

                INC     SI                      ;Bump pointer past word count.
                INC     SI
                MOV     DI,OFFSET WORKSPACE     ;Copy our name.
                CALL    COPY_NAME
                PUSH    CS
                POP     DS
                MOV     DX,OFFSET WORKSPACE     ;Try to write answer.
                CALL    WRITE_ANS
                JNC     ANSWER_END

TRY_CURRENT:    MOV     DX,OFFSET COMPUTE       ;Try current directory.
                CALL    WRITE_ANS
                JNC     ANSWER_END

; See if PATH= is in environment.
                MOV     DS,DS:[2CH]             ;Segment of environment.
LOOK_AT_PATH:   MOV     BX,-1                   ;Offset zero in environment.
NEXT_PATH:      INC     BX
                MOV     SI,BX
                CMP     BYTE PTR [SI],0         ;Terminating null?
                JNZ     PATH_SEARCH
                CMP     BYTE PTR [SI+1],0       ;Double null?
                JNZ     NEXT_PATH
                JMP     SHORT CANT_SAVE         ;If so, end of environment.

PATH_SEARCH:    MOV     DI,OFFSET PATH          ;Search for "PATH=".
                MOV     CX,PATH_LEN
                REPZ    CMPSB
                JNZ     NEXT_PATH

; PATH= found; search for paths.
NEXT_STRING:    CMP     BYTE PTR [SI],0         ;Terminating null?
                JZ      CANT_SAVE
                CMP     BYTE PTR [SI-1],0       ;Double null?
                JZ      CANT_SAVE

MOVE_STRING:    MOV     DI,OFFSET WORKSPACE     ;Get path.
NEXT_BYTE:      LODSB
                OR      AL,AL
                JZ      SEARCH_PATH
                CMP     AL,";"
                JZ      SEARCH_PATH
                STOSB
                JMP     NEXT_BYTE

SEARCH_PATH:    CALL    COPY_PATH               ;Create filespec.
                PUSH    DS
                PUSH    CS
                POP     DS
                MOV     DX,OFFSET WORKSPACE
                CALL    WRITE_ANS               ;Try to write answer.
                POP     DS
                JC      NEXT_STRING             ;If failed, try next path.
                JMP     SHORT ANSWER_END        ;Else, done.

CANT_SAVE:      PUSH    CS
                POP     DS
                MOV     DX,OFFSET NOT_FOUND     ;Answer write error message.
                CALL    PRINT_STRING

ANSWER_END:     RET
```

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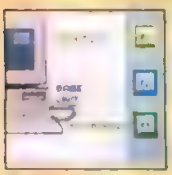
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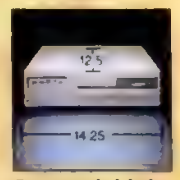

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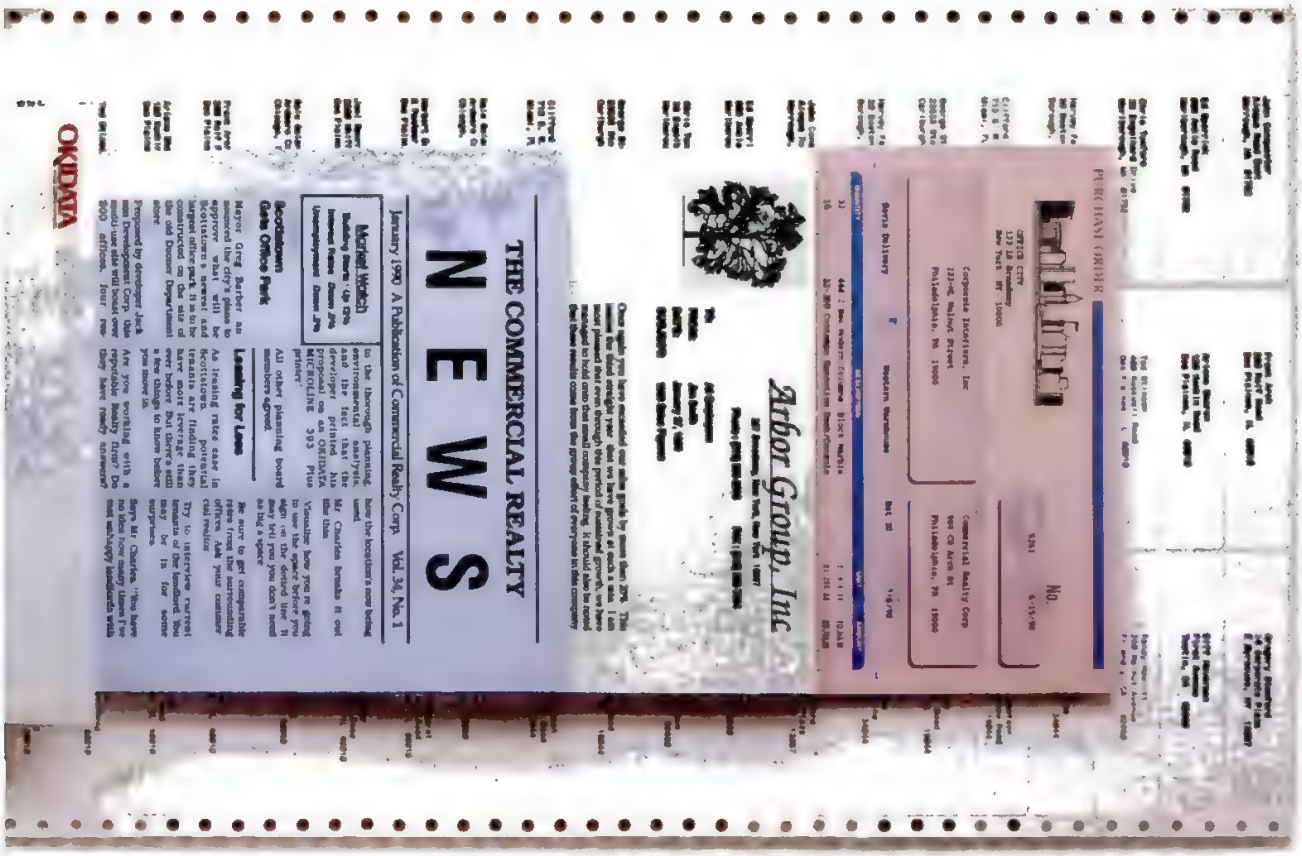

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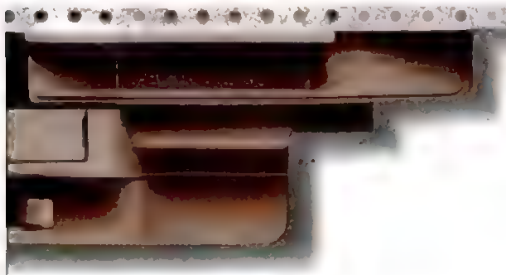

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COMPUTE.ASM


```
;-----------------------------------------------;
COPY_NAME:      LODSB
                STOSB
                OR      AL,AL
                JNZ     COPY_NAME
                RET

;-----------------------------------------------;
COPY_PATH:      PUSH    SI
                PUSH    DS
                CMP     DI,OFFSET WORKSPACE
                JZ      MOVE_NAME
                CMP     BYTE PTR ES:[DI-1],"\"  ;Filespec delimiter?
                JZ      MOVE_NAME
                CMP     BYTE PTR ES:[DI-1],":"
                JZ      MOVE_NAME
                MOV     AL,"\"                  ;If no, add one.
                STOSB

MOVE_NAME:      PUSH    CS
                POP     DS
                MOV     SI,OFFSET COMPUTE       ;Tack on "COMPUTE.COM".
                MOV     CX,COMPUTE_LEN
                REP     MOVSB

COPY_END:       POP     DS
                POP     SI
                RET

;-----------------------------------------------;
; INPUT:  DX -> Compute.com filespec.
; OUTPUT: CY=0 if successful; CY=1 if failed.

WRITE_ANS:      PUSH    SI
                MOV     AX,3D02H                ;Open for reading and writing.
                INT     21H
                JC      WRITE_END
                MOV     BX,AX
                MOV     DX,OFFSET WORKSPACE
                MOV     CX,SIZE WORKSPACE
                MOV     AH,3FH                  ;Read signature.
                INT     21H
                JC      WRITE_END
                MOV     SI,100H                 ;Make sure we found correct
                MOV     DI,OFFSET WORKSPACE     ; Compute.com.
                REP     CMPSB
                STC
                JNZ     WRITE_END

                XOR     CX,CX
                MOV     DX,OFFSET ANSWER - 100H
                MOV     AX,4200H                ;Seek offset of answer.
                INT     21H
                JC      WRITE_END

                MOV     DX,OFFSET ANSWER
                MOV     CX,SIZE ANSWER
                MOV     AH,40H                  ;Write answer to disk.
                INT     21H
                JC      WRITE_END

                MOV     AH,3EH                  ;Close file.
                INT     21H
WRITE_END:      POP     SI
                RET

;-----------------------------------------------;
PRINT_NUMBER:   ADD     AL,"0"                  ;Binary to ASCII.
PRINT_CHAR:     MOV     DL,AL
                MOV     AH,2                    ;Print char via DOS.
                INT     21H
                RET

;-----------------------------------------------;
PRINT_STRING:   MOV     AH,9                    ;Print string via DOS.
                INT     21H
                RET

;-----------------------------------------------;
; HEAP
INITIAL_VALUE   NUMBER  <>

_TEXT           ENDS
                END     START
```

COMPUTE.BAS


```
100 REM - BASIC PROGRAM TO CREATE COMPUTE.COM
110 CLS:PRINT "Creating COMPUTE.COM ": OPEN "COMPUTE.COM " AS #1 LEN = 1
120 FIELD #1, 1 AS A$: CHECKSUM#=0
130 FOR I = 1 TO   160
140  LINESUM#=0: LOCATE 2,3: PRINT "Countdown: "   160 - I ;
150  FOR J = 1 TO  16: READ BYTE$: BYTE = VAL("&H" + BYTE$)
160   CHECKSUM# = CHECKSUM# + BYTE: LINESUM# = LINESUM# + BYTE
170   IF (BYTE < 256) THEN LSET A$=CHR$(BYTE): PUT #1
180  NEXT J
190  READ LINETOT$: LINECHECK# = VAL("&H"+LINETOT$)
200  IF LINECHECK# = LINESUM# THEN GOTO 220
210  LOCATE 4,2: PRINT "Error in line #"  ;  260 +  10 * I: GOTO 260
220 NEXT I
230 CLOSE: READ FILETOT$ : FILECHECK# = VAL(FILETOT$)
240 IF CHECKSUM# <> FILECHECK# THEN GOTO 260
250 PRINT: PRINT "COMPUTE.COM  created successfully": SYSTEM
260 PRINT: PRINT "COMPUTE.COM  is not valid!": END
270 DATA E9, 39,  3,  D, 20, 20, 20,  D,  A, 43, 4F, 4D, 50, 55, 54, 45,   3C6
280 DATA 20, 31, 2E, 30, 20, 20, 43, 29, 20, 31, 39, 39, 30, 20, 5A, 69,   339
290 DATA 66, 66, 20, 43, 6F, 6D, 6D, 75, 6E, 69, 63, 61, 74, 69, 6F, 6E,   642
300 DATA 73, 20, 43, 6F, 2E,  D,  A, 50, 43, 20, 4D, 61, 67, 61, 7A, 69,   496
310 DATA 6E, 65, 20, FE, 20, 4D, 69, 63, 68, 61, 65, 6C, 20, 4A, 2E, 20,   57C
320 DATA 4D, 65, 66, 66, 6F, 72, 64,  D,  A,  A, 24, 53, 79, 6E, 74, 61,   517
330 DATA 78, 3A, 20, 43, 4F, 4D, 50, 55, 54, 45, 20, 61, 72, 69, 74, 68,   527
340 DATA 6D, 65, 74, 69, 63, 20, 65, 7B, 70, 72, 65, 73, 73, 69, 6F, 6E,   682
350 DATA  D,  A, 4F, 70, 65, 72, 61, 74, 6F, 72, 73, 20, 73, 75, 76, 70,   5BE
360 DATA 6F, 72, 74, 65, 64, 20, 61, 72, 65, 20, 2B, 20, 2D, 20, 2A, 20,   470
370 DATA 2F, 20, 25, 20, 20, 20, 29, 20, 5B, 20, 5D, 20, 3B, 2D, 39, 20,   2D3
380 DATA 78,  D,  A, 4E, 6F, 74, 65, 3A, 20, 25, 20, 3D, 20, 6D, 6F, 64,   461
390 DATA 75, 6C, 6F, 2C, 20, 72, 65, 6D, 61, 69, 6E, 64, 65, 72, 20, 6F,   5E2
400 DATA 66, 20, 69, 6E, 74, 65, 67, 65, 72, 20, 64, 69, 76, 69, 73, 69,   61C
410 DATA 6F, 6E, 2E,  D,  A, 20, 20, 20, 20, 20, 20, 78, 20, 3D, 20, 61,   330
420 DATA 6E, 73, 77, 65, 72, 20, 6F, 66, 20, 6C, 61, 73, 74, 20, 63, 6F,   5EA
430 DATA 6D, 70, 75, 74, 65, 2E,  A,  D,  A, 24, 1A, 7C,  A, 2B, 2D, 2A,   3C0
440 DATA 2F, 25, 20, 5B,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,    D7
450 DATA  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,     0
460 DATA  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,     0
470 DATA  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,     0
480 DATA  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,     0
490 DATA  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,     0
500 DATA  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,     0
510 DATA  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,     0
520 DATA  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,     0
530 DATA  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,     0
540 DATA  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,     0
550 DATA  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,     0
560 DATA  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,     0
570 DATA  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  5,  3,  3,  3,    16
580 DATA  3,  3,  3,  3,  3,  3,  3,  3,  3,  3,  3,  3,  3,  3,  3,  3,    30
590 DATA  3,  0,  0,  0,  0, 43, 4F, 4D, 50, 55, 54, 45, 2E, 43, 4F, 4D,   32D
600 DATA  0, 50, 41, 54, 48, 3D,  D,  A, 43, 6F, 75, 6C, 64, 20, 6E, 6F,   475
610 DATA 74, 20, 73, 61, 76, 65, 20, 61, 6E, 73, 77, 65, 72, 20, 69, 6E,   5EA
620 DATA 20, 43, 6F, 6D, 70, 75, 74, 65, 2E, 63, 6F, 6D,  D,  A, 43, 6F,   533
630 DATA 6D, 70, 75, 74, 65, 2E, 63, 6F, 6D, 20, 6D, 75, 73, 74, 20, 62,   683
640 DATA 65, 20, 69, 6E, 20, 63, 75, 72, 72, 65, 6E, 74, 20, 64, 69, 72,   5DE
650 DATA 65, 63, 74, 6F, 72, 79,  D,  A, 6F, 72, 20, 69, 6E, 20, 44, 4F,   538
660 DATA 53, 20, 50, 41, 54, 48, 3D, 20, 64, 69, 72, 65, 63, 74, 6F, 72,   559
670 DATA 79, 2E,  D,  A, 24, 52, 65, 73, 75, 6C, 74, 20, 69, 73, 20, 24,   4A1
680 DATA 55, 6E, 72, 65, 63, 6F, 67, 6E, 69, 7A, 65, 64, 20, 63, 68, 61,   639
690 DATA 72, 61, 63, 74, 65, 72, 24, 4D, 69, 73, 73, 69, 6E, 67, 20, 70,   68F
700 DATA 61, 72, 65, 6E, 74, 68, 65, 73, 69, 73, 20, 6F, 72, 20, 62, 72,   628
710 DATA 61, 63, 6B, 65, 74, 24, 4D, 69, 73, 73, 2D, 6D, 61, 74, 63, 68,   682
720 DATA 65, 64, 20, 70, 61, 72, 65, 6E, 74, 68, 65, 73, 69, 73, 20, 77,   62F
730 DATA 69, 74, 68, 20, 62, 72, 61, 63, 6B, 65, 74, 24, 44, 69, 76, 69,   5F1
740 DATA 64, 65, 20, 62, 79, 20, 7A, 65, 72, 6F, 24, 4F, 76, 65, 72, 66,   5CA
750 DATA 6C, 6F, 77, 24, 4C, 6F, 67, 69, 63, 20, 65, 72, 72, 6F, 72, 24,   5D2
760 DATA 52, 65, 71, 75, 69, 72, 65, 73, 20, 31, 38, 4B, 20, 6F, 66, 20,   531
770 DATA 6D, 65, 6D, 6F, 72, 79, 24, 45, 72, 72, 6F, 72, 20, 5E,  D,  A,   55C
780 DATA 24, 5E, 20, 45, 72, 72, 6F, 72, 24,  D,  A, 24, FC, BA,  3,  1,   4C5
790 DATA E8, 34,  8, BB,  0,  0, B4, 4A, CD, 21, BA, 10,  4, 72, 37, BC,   3FC
800 DATA FE, 3F, BE, 81,  8, 33, C0, 33, D2, E8, 86,  8, E8, C1,  1, BA,   846
810 DATA  4,  4, 73, 22, 81, 3E,  B,  2, 7C,  A, 75,  8, BA, 5B,  1, E8,   46A
820 DATA  5,  6, EB, 69, BA, A7,  3, 83, 3E, 16,  2,  0, 75,  8, E8, 5B,   55C
830 DATA  4, B8,  8, 4C, CD, 21, 52, BA, 5B,  1, E8, EA,  5, 5A, E8, E6,   75D
840 DATA  5, BA,  6,  2, E8, E8,  5, 8B, DE, BE, 81,  8, FC, B9, 4F,  0,   740
850 DATA AC, 3C,  D, 74, 11, E8, C8,  5, 3B, F3, 74,  A, E2, F2, BA,  7,   770
860 DATA  2, E8, C3,  5, EB, E7, BA,  7,  2, E8, B8,  5, 83, E9, 4F, F7,   8A1
870 DATA D9, BB, 27,  4, 83, F9, 28, 72,  5, 83, E9,  6, EB,  3, BB, 31,   726
880 DATA  4, B0, 28, E8, 9A,  5, E2, F9, 8B, D3, E8, 9A,  5, B8,  1, 4C,   820
890 DATA CD, 21, 55, 52, 50, 8B, EC, E8, 36,  1, 73,  3, E9, 29,  1, AC,   6B8
900 DATA BF,  D,  2, B9,  5,  8, F2, AE, 75, 75, 32, D2, 3C, 2B, 74,  4,   5F9
910 DATA 3C, 2D, 75, 11, 50, A0, 15,  2, BF,  F,  2, B9,  6,  8, F2, AE,   525
920 DATA 58, 75,  2, FE, C2, FF, 36, 15,  2, A2, 15,  2, FF, 36,  B,  2,   5D6
930 DATA E8, BF, FF, 5B, 59, 8A, F8, 8B, 3E,  B,  2, 8A,  5, 8A, 27, 08,   76A
940 DATA FE, 2A, 74, 28, 88, FE, 2F, 74, 28, 88, FE, 25, 74, 28,  A, D2,   728
950 DATA 74,  A, 8A, C1, E8, E8,  8, 75, 9E, E9, CC,  8, E8, 69,  1, A8,   853
960 DATA 15,  2, 3C, 29, 74, 16, 3C, 5D, 74, 12, EB, 8B, E8, B5,  1, EB,   624
970 DATA 86, E8, 2E,  2, EB, 81, E8,  3,  3, E9, 7B, FF, E9, A9,  8, A2,   88F
980 DATA 15,  2, 3C, 58, 74,  4, 3C, 78, 75, 22, 56, BE, D8,  2, 83,  6,   4E5
990 DATA  B,  2, 29, 8B, 3E,  B,  2, 57, B9, 29,  8, F3, A4, 5F, 8A, 46,   50B
1000 DATA  0, 3C, 2D, 74,  2, 32, C8, 3B,  5, 5E, EB, 15, 3C, 2E, 74,  8,   44A
1010 DATA 3C, 38, 72, 1E, 3C, 39, 77, 1A, 4E, 83,  6,  B,  2, 29, E0, 87,   47E
1020 DATA  0, 88, 7E,  2,  1, 74, 41, 8A, 46,  8, E8, 72,  8, 74, 59, E9,   5B6
1030 DATA 25, FF, B4, 29, 3C, 28, 74, 24, 3A, C4, 74,  D, B4, 5D, 3C, 5B,   624
1040 DATA 74, 1A, 3A, C4, BA, 98,  3, 75, 43, FF,  E, 16,  2, BA, A7,  3,   61A
1050 DATA 72, 3A, 8B, 1E, 16,  2, 88, A7, 10,  2, EB, 2C, FF, 36, 16,  2,   51A
1060 DATA FF,  6, 16,  2, 33, D2, E8, E9, FE, 5B, 3A, A7, 10,  2, BA, C6,   7C7
1070 DATA  3, 75, 19, 8A, 46,  0, E8, 26,  0, 74,  D, 3C, 2D, 75,  6, 8B,   45F
1080 DATA 1E,  B,  2, 38,  7, E9, CF, FE, 58, 5A, 5D, C3, E9, 67, FE, C3,   7FB
1090 DATA AC, 3C,  D, 74,  7, 3C, 20, 76, F7, 4E, F8, C3, 4E, F9, C3, BF,   88B
1100 DATA  F,  2, B9,  3,  8, F2, AE, C3, BF, 4A,  2, B9, 15,  8, AC, 3C,   5F1
1110 DATA 2C, 74, FB, 3C, 2E, 74, 12, 2C, 38, 72,  D, 3C,  9, 77,  9, AA,   4D5
1120 DATA E2, EC, BA, FB,  3, E9, 2E, FE, 4E, 56, 8B, F7, 4E, 9C, FD, 8B,   A33
1130 DATA 3E,  B,  2, 83, C7, 14, 88, D1, 4A, F7, D8, 83, C1, 15, 83,  2,   75D
1140 DATA F3, A4, 8B, CA, E3,  4, 32, C8, F3, AA, 8A, 46,  8, 3C, 2D, 74,   88F
1150 DATA  2, 32, C8, AA, 9D, 5E, 8B, 3E,  B,  2, 83, C7, 15, B9, 15,  8,   59C
1160 DATA 33, D2, AC, 2C, 30, 72,  E, 3C,  9, 77,  A, AA, 42, E2, F3, BA,   6CE
1170 DATA FB,  3, E9, E1, FD, 4E, 3B, 16,  1,  3, 76,  4, 89, 16,  1,  3,   585
1180 DATA 49, E3,  4, 32, C8, F3, AA, C3, 9C, 56, FD, C6,  6,  3,  3,  8,   743
1190 DATA 8B, D3, B9, 28,  8,  3, F9,  3, D9, 8B, F3, 3A, C4, 74, 2A, 3C,   76D
1200 DATA 2D, 74,  6, 87, FE, 89, 16,  8,  2, 8B, DF, F8, AC, 1A,  5, 3F,   644
1210 DATA AA, E2, F9, 88,  8, 73, 22, 8B, FB, F8, B9, 28,  8, 8A, C5, 1A,   892
1220 DATA  5, 3F, AA, E2, F8, 88, 2D, EB, 18, A2,  3,  3, F8, AC, 12,  5,   703
1230 DATA 37, AA, E2, F9, 72,  7, A0,  3,  3, AA, 5E, 9D, C3, BA, FB,  3,   7FB
1240 DATA 5E, E9, 72, FD, 55, 9C, 56, 32, D2, 3A, C4, 74,  2, B2, 2D, 88,   7DC
1250 DATA 16,  3,  3, FD, B3, C7, 28, 83, C3, 28, 8B, EF, BF, 99,  2, 8B,   750
```

COMPUTE.BAS: Running this listing in BASIC will automatically produce the COMPUTE.COM utility.

COMPUTE.BAS 2 of 2

```
1260 DATA D7, 33, C0, B9, 50,  0, F3, AA, 8B, FA, B9, 28,  0, 57, 8A,  7,  7BE
1270 DATA  A, C0, 74, 1D, 51, B9, 28,  0, 8A, D0, 8B, F5, 32, F6, AC, F6,  831
1280 DATA E2, D4,  A,  2,  5, 37,  2, C6, 37, AA, 6A, F4, E2, F0, 8B, 25,  7A4
1290 DATA 59, 5F, 4B, 4F, E2, D7, BF, 86,  2, B9, 28,  0, E8, 58,  1, BE,  732
1300 DATA 85,  2, 8B, FD, B9, 28,  0, F3, A4, A0,  3,  3, AA, B9, 14,  0,  6A4
1310 DATA AC,  A, C0, 75,  6, E2, F9, 5E, 9D, 5D, C3, BA, FB,  3, 5E, E9,  8E6
1320 DATA F4, FC, 55, 9C, 56, 32, D2, 3A, C4, 74,  2, B2, 2D, B8, 16,  3,  72F
1330 DATA  3, 8B, E7, 45, BF, 4A,  2, 32, C0, B9, 3D,  0, F3, AA, BF, 9A,  7AB
1340 DATA  2, AA, 8B, F3, 46, B9, 28,  0, F3, A4, B9, 15,  0, F3, AA, 8B,  7DE
1350 DATA FD, B9, 28,  0, F3, AE, 75,  7, BA, EC,  3, 5E, E9, B7, FC, BF,  95D
1360 DATA 4A,  2,  3, F9, 83, C5, 27, 2B, E9, 41, 8B, D1, BE, 9B,  2, B9,  77C
1370 DATA 3E,  0, 2B, CA, 80, 3E,  4,  3,  1, 75,  6, 81, FF, 72,  2, 73,  4DB
1380 DATA 78, 51, 57, 8B, DE, 32, F6, 80, 7C, FF,  0, 75,  D, 8A, CA, 32,  7AC
1390 DATA ED, 8B, FD, A6, 77,  4, 72, 27, E2, F9, FE, C6, 8B, F5, 8B, FB,  AD4
1400 DATA 8A, CA, 32, ED, 49,  3, F1,  3, F9, 41, FD, F8, AC, 8A, E0, 0A,  982
1410 DATA  5, 1A, C4, 3F, AA, E2, F5, 80, 1D,  0, FC, 6B, F3, EB, C0, 6B,  8F8
1420 DATA F3, 5F, 59, 8A, C6, AA, 46, E2, AB, BF, 84,  2, B9, 28,  0, FD,  89D
1430 DATA E8, 84,  0, 72, 28, B9, 28,  0, BE, 85,  2, 0B, 3E,  0,  2,  1,  4FD
1440 DATA F9, F3, A4, A0,  3,  3, AA, B9, 14,  0, AC,  A, C0, 75,  6, E2,  78B
1450 DATA F9, 5E, 9D, 5D, C3, BA, FB,  3, 5E, E9, 1A, FC, 58, 57, 83, C7,  91A
1460 DATA 15, B9, 14,  0, FD, E8, 4F,  0, 72, 39, 5F, 57, E8, 1A,  8, 8B,  624
1470 DATA FB, 83, C7, 15, B9, 14,  0, E8, 3D,  0, 72, 27, 8B, FB, E8, 28,  77B
1480 DATA  0, 5F, C6,  6,  4,  3,  1, FC, E8, F7, FE, C6,  6,  4,  3,  0,  5DF
1490 DATA 8B, 3E,  8,  2, 58, BA, C4, AA, 56, BE, 9B,  2, B9, 28,  0, F3,  6AB
1500 DATA A4, 5E, C3, BA, FB,  3, E9, CD, F8, 9C, FC, 83, C7, 15, B9, 14,  9F2
1510 DATA  0, 32, C0, F3, AA, 9D, C3, 80, 3D,  5, 72,  E, 4F, F9, 8A,  5,  700
1520 DATA 14,  0, 37, AA, 73,  5, E2, F6, EB,  5, FB, C3, BA, 85,  3, E8,  816
1530 DATA 95,  1, 8B, 36,  8,  2, AC,  A, C0, 74,  3, E8, 82,  1, 32, F6,  5E4
1540 DATA 83,  3, B9, 14,  0, EB, 11,  A, F6, 74,  D, 0B, C1, F6, F3,  A,  73F
1550 DATA E4, 75,  5, B0, 2C, E8, 68,  1, AC,  A, C0, 75,  4,  A, F6, 74,  6EE
1560 DATA  5,  A, F0, E8, 58,  1, E2, DF, 56, B9, 14,  0, 8B, D9, 43, AC,  777
1570 DATA  A, C0, 74,  2, 8B, D9, E2, F7, 5E, F7, DB, 83, C3, 15, 8B,  E,  8A1
1580 DATA  1,  3, 3B, CB, 73,  2, 8B, CB, E3, 26,  A, F6, 75,  5, 32, C0,  64A
1590 DATA E8, 2B,  1, B0, 2E, E8, 28,  1, 32, D8, 80, FB,  3, 75,  7, B0,  6BA
1600 DATA 2C, E8, 1C,  1, 32, DB, AC, E8, 14,  1, FE, C3, E2, EC, EB,  9,  86A
1610 DATA  A, F6, 75,  5, 32, C0, E8,  5,  1, BA,  7,  2, E9,  6,  1, 8B,  599
1620 DATA 36,  8,  2, BF, D8,  2, B9, 29,  8, F3, A4, B4, 30, CD, 21, 3C,  663
1630 DATA  3, 72, 22, 8E, 1E, 2C,  0, 33, F6, AC,  A, C0, 75, FB, AC,  A,  634
1640 DATA C0, 75, F6, 46, 46, BF, 4A,  2, E8, 67,  0,  E, 1F, BA, 4A,  2,  644
1650 DATA E8, 8C,  0, 73, 5C, BA,  5,  3, E8, 84,  0, 73, 54, 8E, 1E, 2C,  610
1660 DATA  0, BB, FF, FF, 43, 8B, F3, 80, 3C,  0, 75,  8, 80, 7C,  1,  0,  680
1670 DATA 75, F2, EB, 35, BF, 11,  3, B9,  5,  0, F3, A6, 75, E6, 80, 3C,  7C0
1680 DATA  0, 74, 26, 80, 7C, FF,  0, 74, 20, BF, 4A,  2, AC,  A, C0, 74,  61E
1690 DATA  7, 3C, 3B, 74,  3, AA, EB, F4, E8, 1E,  0, 1E,  E, 1F, BA, 4A,  5D3
1700 DATA  2, E8, 3B,  0, 1F, 72, D7, EB,  8,  E, 1F, BA, 16,  3, E8, 76,  5DE
1710 DATA  0, C3, AC, AA,  A, C0, 75, FA, C3, 56, 1E, 01, FF, 4A,  2, 74,  7C9
1720 DATA 11, 26, 80, 7D, FF, 5C, 74,  A, 26, 80, 7D, FF, 3A, 74,  3, B0,  690
1730 DATA 5C, AA,  E, 1F, BE,  5,  3, B9,  C,  0, F3, A4, 1F, 5E, C3, 56,  5EB
1740 DATA B8,  2, 3D, CD, 21, 72, 35, 8B, D0, BA, 4A,  2, B9, 50,  0, B4,  6B7
1750 DATA 3F, CD, 21, 72, 27, BE,  0,  1, BF, 4A,  2, F3, A6, F9, 75, 1C,  6B3
1760 DATA 33, C9, BA, D8,  1, B8,  0, 42, CD, 21, 72, 10, BA, D8,  2, B9,  746
1770 DATA 29,  0, B4, 40, CD, 21, 72,  4, B4, 3E, CD, 21, 5E, C3,  4, 30,  5B6
1780 DATA 0A, D0, B4,  2, CD, 21, C3, B4,  9, CD, 21, C3,  0,  0,  0,  0,  62F
1790 DATA  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0
1800 DATA  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0
1810 DATA  0,  0,  0,  0,  0, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A,  11E
1820 DATA 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A,  1A0
1830 DATA 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A,  1A0
1840 DATA 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A,  1A0
1850 DATA 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A,  1A0
1860 DATA 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A, 1A,  1A0
1870 DATA 230290
```

add greater precision, but the binary base still entails the possibility of round-off errors. What to do?

BINARY-CODED DECIMAL

This is where BCD numbers come into play. Instead of binary, the mantissa of BCD floats are in base 10, the same base we commonly use in our own calculations. Since BCD numbers are base 10, there is no round-off error in the computer. In BCD, 4 bits are needed to represent the decimal digits from 0 through 9. 0000b is, of course, 0 and 1001b is 9. Four bits, of course, conveniently fit in half a byte (known as a nibble).

There are two BCD formats: packed and unpacked. Packed BCD numbers are made up of bytes that contain two decimal digits, one in the upper 4 bits, the other in the lower 4 bits. Unpacked BCD numbers contain only one decimal digit per byte, which means that the upper 4 bits of unpacked BCD numbers are always 0.

With 10-byte packed BCD floats, 9 bytes are reserved for the mantissa. At two digits per byte, this provides 18 digits of precision. The 7 bits of the exponent provide a large range: $1.0 * 10^{-63}$ to $1.0 * 10^{+63}$. And most important, there is *no* decimal round-off error, since the numbers are already decimal.

The disadvantage of BCD numbers, however, is that they are not as compact: 10 bytes in the case of packed BCD, versus 6 or 8 bytes for binary reals. In a large spreadsheet this can be a major problem. And, of course, unpacked BCD numbers require twice as much memory as packed BCD numbers do.

You might think that doing calculations with BCD numbers would be a nuisance because base 10 is "foreign" to the computer. Fortunately, however, there are special CPU instructions dedicated to handling both packed and unpacked BCD arithmetic. The sidebar "Binary Coded Decimal Instructions" describes these instructions, and the sidebar "Binary Coded Decimal Addition" provides a code example of BCD arithmetic. Both sidebars, as noted earlier, are available only on PC MagNet.

FIXED POINT

The nasty part of using floating-point calculations, whether binary or BCD, is the need to manipulate the exponent before operating on the numbers. For example, adding $34 * 10^{+2}$ to $54 * 10^{-2}$ requires shifting to line up the mantissa before the addition; just adding 34 to 54 results in an incorrect answer. It's much easier to calculate using fixed-point numbers, since the decimal point is already in the right place. The disadvantage is that fixed-point numbers have a more limited range for a given number of storage bytes.

Of the two BCD formats, packed has a small disadvantage over unpacked. Some arithmetic operations, and all conversion to and from ASCII decimal, require the shifting and masking of digits to and from their packed state. Unpacked numbers are already in a byte of their own.

In writing COMPUTE, I chose to use a fixed-point, unpacked BCD format. The fixed point simplifies each of the arithmetic procedures, the BCD avoids round-off errors, and unpacked format avoids the packing process. Each number in COMPUTE thus uses 41 bytes of memory. The first byte holds the sign, the next 20 bytes hold the integer portion, and the last 20 bytes hold the decimal portion. The decimal point itself is implied between the integer and fraction.

The only disadvantage of this format is the much larger memory requirement for a number. In a large number-crunching application, 41 bytes per number would be prohibitive. For the relatively few numbers COMPUTE has to hold, however, memory is not a concern. The 20- and 20-precision actually was arbitrarily chosen and could have easily been increased, though I am confident that it is more than adequate for our needs. (Bill Gates might find COMPUTE's range insufficient to calculate the current value of his stock, but it should suffice for the rest of us.)

For programmers who may have been mystified by Intel's BCD instructions, I hope the sidebars clarify matters. Download the COMPUTE source code from PC MagNet to study the other complete BCD arithmetic functions, and join us on MagNet if you have any questions.

And for all of our readers, using COMPUTE will get you fast results with very high precision right from the DOS prompt. That's a long step forward in making your PC fulfill its promise to simplify your daily work. ■

Michael J. Mefford is a contributing editor of PC Magazine.

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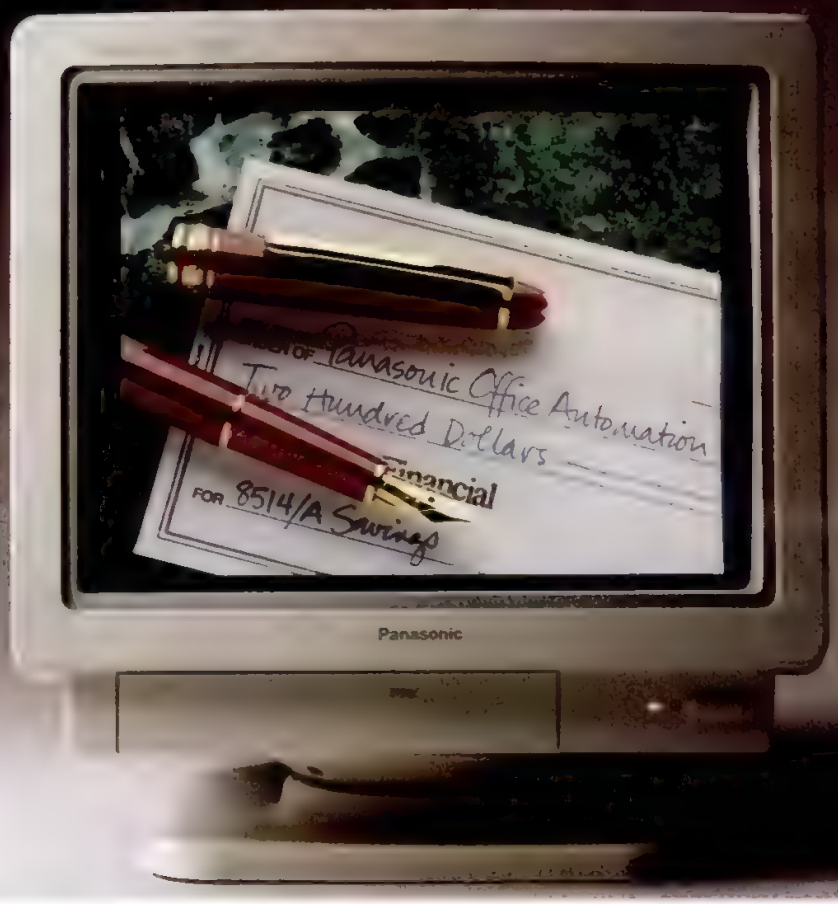

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M3-PCM

by
Charles Petzold

Environments

Programming for Multithreaded Drawing, Part 1

Computers will never be quite fast enough. Each improvement in hardware performance lets us run existing software faster, of course, but we also devise more-difficult chores for the better machines. During the 1990s, we'll see personal computers performing feats that would require so much processing time on existing machines that they are currently impractical. But the PCs of tomorrow will not perform these feats instantaneously. Waiting for the computer is a perennial condition for users.

The best that software developers can do is write code that minimizes waiting. Part of this task is realized by tight, efficient coding. But OS/2 programmers can also improve performance by taking advantage of multithreaded programming techniques. While one execution thread of a program is interacting with the user, other threads running concurrently in the background can do work behind the scenes. Such programs will also be ready for the multiprocessing hardware expected to be common during the 1990s.

As I discussed in the last issue, using multiple threads is particularly important in programming for the OS/2 Presentation Manager. Because the Presentation Manager serializes all user input in the PM session, a PM program that takes a long time to process a message can seemingly shut down all of PM. If this is the case with your PM program, you should seriously consider moving the lengthy processing to a separate thread.

THE PROBLEM OF DRAWING

There is no question that multithread programming is more complex than single-thread programming. When different parts of your program are running concurrently, you must ensure that functions used by multiple threads are reentrant and that one thread does not damage variables required by another thread.

The PRINTCAL program presented in the February 27, March 27, and April 24, 1990, Environments columns showed how to print from a separate thread of execution. Structurally, PRINTCAL's use of multiple threads was rather simple: on receipt of a WM_COMMAND message signaling that the user wanted to print the calendar, the client window procedure first allocated memory for a structure called THREADPARAMS. This structure included the thread's stack and all the information necessary to print the calendar. A pointer to this structure was passed to the _beginthread function to start the thread.

> ■ Using a second thread of execution and creating a shadow bitmap, you can trade memory for increased execution speed.

The thread printed the calendar. It then notified the client window procedure of the job's completion (or of an error encountered during printing) by posting a message to the window, using the WinPostMsg function. The client window procedure then notified the user with a message box that the job was finished.

This was structurally simple, because once started, the printing thread would run by itself until finished. There was no way for the user or the program to interrupt the thread. In effect, the program said to the printing thread: "Do this job and tell me when you're done."

Multithread programming is not always this easy. For example, suppose a PM spreadsheet program uses a second thread for recalculation. When the user types a new cell entry, the program starts the thread, recalculating all the new cell values. Perhaps before the recalculation is complete, the user types another cell entry. The program must stop the background recalculation and start it over again with the new values. In effect, the program has to say to the second thread: "Stop that job I gave you to do a moment ago. You have to do it a little differently now."

Drawing on a window from a second thread of execution can also be tricky, because the window image is usually dependent on user input. For example, suppose the image is based on the size of the window. The user could change the window size while the image is being drawn. The program must stop drawing the image and begin it again with the new window size.

In this and the next several columns, I'll discuss drawing on your window from a separate thread of execution. The sample programs that demonstrate these techniques will be called THREADS1, THREADS2, and so forth. I'll begin in this column with THREADS1, which is the simplest case: a complex static image that is independent of window size.

A COMPLEX STATIC IMAGE

The THREADS1 program displays a moderately complex (at least in terms of processing requirements) graphical image. Figure 1 shows THREADS1 running under the OS/2 Presentation Manager on an IBM 8514/A video adapter. The program

runs on an EGA and VGA too, of course, but that doesn't look nearly as nice, because of the color limitations. The 8514/A can use 256 simultaneous colors under PM, while the EGA and VGA are restricted to 16 colors.

THREADS1 makes use of the Times Roman Bold vector font (which, for copyright reasons, is called Tms Rmn Bold) available through the OS/2 Graphics Programming Interface (GPI). The program scales the font to a 500-point size. A point is $1/n$ inch, so a 500-point font has letters that measure about 7 inches from the bottom of the descenders to the top of the ascenders.

THREADS1 displays the letters *PC* in this font. But rather than *directly* displaying the letters, the program uses the outline of the letters to define a clipping area. This means that subsequent drawing is restricted to the interior of the letters.

THREADS1 then draws 64 areas, each delimited by a pair of closely spaced parallel Bézier spline curves. The areas are filled with a range of colors starting with black at the bottom, becoming red in the middle, and then gradually shifting to white at the top. This creates an effect known as a *fountain*.

The calculations that GPI performs to generate this image are not trivial. For each of the 64 areas, GPI must algorithmically find the intersection of the character outlines used as the clipping area and the area between each pair of spline curves. This requires about a minute of processing time on a 20-MHz 386 machine.

There is a customary way to structure a PM program that does nothing but display a static image: the window procedure for the client window draws the image during the WM_PAINT message. A window procedure receives a WM_PAINT message whenever part of the window is invalid and must be repainted.

But the image that THREADS1 draws requires so much processing time that this solution would be unsatisfactory. The program would require a minute of initialization when you first loaded it into memory. Whenever you resized the window, the program would spend time repainting its window again. If you minimized and then restored the program to its original size, it would again have to repaint the window. If part of the window were obscured by another window and then reexposed, the program would have to repaint the window still again.

Figure 1: A sample PM program, THREADS1, creates a bitmap of the image in a second thread of execution. The program *then* copies the bitmap to a Window. Using a second thread lets you manipulate a program while processing is done in the background.

In each case you probably wouldn't be able to work with any program running in the PM session while THREADS1 was refreshing its window. For example, suppose you were to change the size of the program's window. At this point the window is active and it begins repainting itself. You couldn't switch to another program, because this would require PM to send THREADS1 messages indicating (among other things) that it was losing the input focus. THREADS1 couldn't process this message, because it would be busy drawing.

But if you move the window drawing in THREADS1 to a separate thread, some of these problems would be solved. While THREADS1 was drawing its window, you could switch to another program in the PM session and get something else done.

Indeed, since the image doesn't change, it really shouldn't be necessary to spend time drawing it more than once.

THE BITMAP SOLUTION

The solution to this problem is a bitmap. A bitmap is simply a rectangular array of bits stored in memory that correspond to the pixels of a graphics output device. The bitmap height and width is the size of the image in pixels. If the image is drawn on a bitmap rather than directly to the window, then the window procedure could process a WM_PAINT message very quickly by copying the bitmap to the window.

A bitmap used in this way is sometimes called a *shadow bitmap*. The bitmap always retains the current window image so that the window can be updated from the bitmap at any time.

Of course it would still require a minute or so of processing time to create the bitmap. For this reason, the program should create the bitmap in a second thread of execution. This is what THREADS1 does.

Although THREADS1 shows how to create only a static image on a bitmap and update the window from the bitmap, this technique can also be used by applications (drawing programs, for example) that display a complex image that can be changed by the user. Whenever the user adds a new object to the drawing, or when he removes an object, the program alters the image in both the window and the shadow bitmap.

If the image (and hence the bitmap) is larger than the window, then the window can include scroll bars to move the image within the window. This scrolling can be very fast, because it's only a matter of drawing a different section of the bitmap to the window.

THE THREADS1 SOURCE CODE

The three files necessary to create THREADS1.EXE are available on PC MagNet. If you have the Microsoft C 5.1 compiler and the Microsoft or IBM OS/2 programmer's toolkit installed, you can create THREADS1.EXE by executing

```
MAKE THREADS1
```

You can also download the executable file, THREADS1.EXE, from PC MagNet.

There are several aspects of this program that you may find of interest. I'll start at the bottom (the code to draw the image itself) and work up through the creation of the bitmap that stores this image, and then I'll get to the code that creates the thread that creates the bitmap.

DRAWING THE IMAGE

Near the end of THREADS1.C is a function called DrawImage, which draws the image. The two parameters to the function are a handle to a presentation space (this is required as the first parameter to the GPI drawing functions) and a pointer to a structure of the type SIZEL. This structure defines the size of the area in which the image appears. (We'll see shortly that this size is the size of the bitmap, which is based on the size of the characters *PC* in a 500-point Times Roman Bold font.)

DrawImage begins by calling GpiSetColor, GpiMove, and GpiBox to color the entire background of the image blue. A call to the CreateVectorFont function sets up an FATTRS (font attributes) structure and calls GpiCreateLogFont to create the font. GpiSetCharSet selects that font for the presentation space.

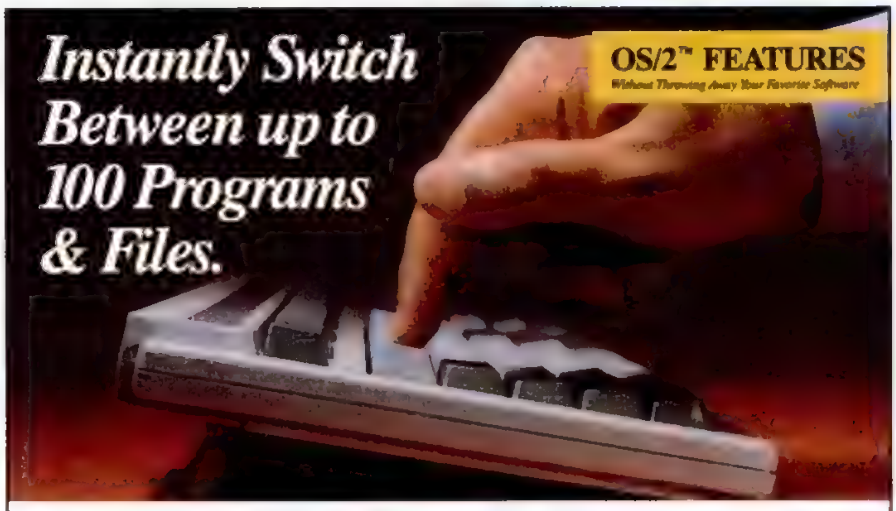
DrawImage scales the font with a call to GpiSetCharBox. This code assumes that the page units of the presentation space are those known as PU_TWIPS. When you create a presentation space by calling GpiCreatePS, you indicate the page units you wish to use for defining coordinate points in the GPI drawing functions. PU_TWIPS is one possible option. (We'll see shortly that PU_TWIPS is used for the *memory presentation space* created for the bitmap.) *Twip* is a coined word that stands for "twentieth of a point." A point is $^1/_{72}$ inch, so a twip is $^1/_{1,440}$ inch. Thus, the desired size of the font passed to GpiSetCharBox is 20 times the point size.

At this point, text could be drawn on the presentation space by calls to GpiCharStringAt. But that's not quite what we want to do. We want the outline of the characters to define a clipping area. To do this, DrawImage first calls GpiBeginPath. This begins a *path bracket*. Lines drawn by subsequent GPI functions are accumulated in memory as a path, which is simply a collection of lines. (The concept of a path was influenced by PostScript, in which all lines begin as paths.)

DrawImage then calls GpiQueryTextBox, to determine the starting position of the string, and GpiCharStringAt, to make the character outline part of the path. A call to GpiEndPath ends the path bracket. GpiSetClipPath makes the interior of the path the current clipping area. Keep in mind that nothing has been drawn on the presentation space by this sequence of functions.

Now it's time to draw the areas delimited by the pairs of Bézier spline curves. A call to GpiCreateLogColorTable switches the presentation space to an RGB (red-green-blue) color mode, in which colors are specified by an 18-bit value rather than by a color index. This is necessary to produce the various shades of red used in the image.

For each of the 64 areas, DrawImage calls GpiSetColor to set a color. It then de-



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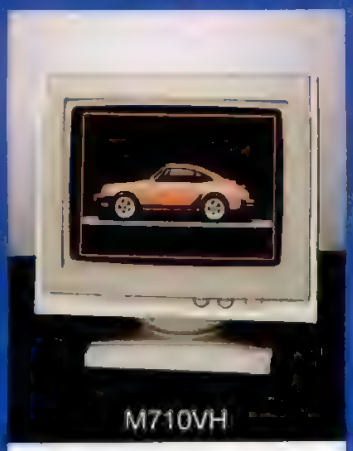

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fines eight elements of a POINTL array for a pair of Bézier spline curves connected at the ends by short lines. A call to GpiBeginArea begins an *area bracket*. Somewhat like the path bracket used earlier, an area bracket accumulates lines that define an enclosed area. Calls to GpiMove, GpiPolySpline, and GpiLine draw the outline of an area. The area bracket is ended with a call to GpiEndArea. This causes GPI to fill the area delimited by the accumulated lines.

To create the bitmap, let's continue working our way upward in the THREADS1.C program, to the CreateBitmap function. The function begins by calling DevOpenDC with an OD_MEMORY parameter to open a *memory device context*. Usually the term *device context* refers to a graphics output device and its device driver. But to draw on a bitmap you must treat the bitmap as if it were the display surface of an output device. This is what the memory device context allows. The last parameter of DevOpenDC is set to NULL to indicate that the memory device context is compatible with the video display.

A call to GpiCreatePS creates a presentation space associated with the memory device context. This is sometimes called a memory presentation space. Notice that the PU_TWIPS identifier is used to specify page units of $^1/_{1,440}$ inch.

As in the DrawImage function, CreateBitmap calls CreateVectorFont, GpiSetCharSet, and GpiSetCharBox to select a 500-point Times Roman Bold font in the presentation space. The sole purpose of this set of calls is to determine the size of the character string that appears in the image (and hence the size of the required bitmap) by a call to GpiQueryTextBox. But the size of the character string returned from GpiQueryTextBox is in units of twips, and the size of the bitmap must be specified in units of pixels. GpiConvert converts from page units to pixels.

A call to GpiQueryDeviceBitmapFormats obtains the color format (number of color planes and number of bits per pixel) of the video display. This information and the bitmap size are used to set up a BITMAPINFOHEADER structure for the call to GpiCreateBitmap.

The GpiSetBitmap function sets the bitmap in the memory presentation space. This means that anything drawn to the presentation space will actually be drawn on the bitmap. CreateBitmap then calls DrawImage to draw the image on the bitmap. Cleaning up, the function destroys the memory presentation space, closes the memory device context, and returns the handle to the bitmap.

THE WINDOW AND THE THREAD

Now that we're familiar with the code to create the bitmap and with the code to draw the image on the bitmap, it's time to examine how the bitmap is created in a separate thread of execution.

THREADS1's main function is normal. It creates a standard window where ClientWndProc is the window procedure for the client window. During the WM_CREATE message in ClientWndProc, the client window allocates memory for a structure of the type THREADPARAMS. This structure includes the thread's stack, a field for the thread to return the bitmap handle, and a field for the handle of the client window.

A call to _beginthread starts the second thread, which (appropriately enough) is a function called SecondThread. This function runs concurrently with the program's main thread, so you can still interact with the window (for example, move it, resize it, and switch to another window) while the bitmap is being created.

The SecondThread function calls WinInitialize for the thread, and then CreateBitmap to create the bitmap. When CreateBitmap returns, the thread notifies the window procedure of completion by calling WinPostMsg to post a user-defined message I've called WM_BITMAP_CREATED. The first message parameter is a pointer to the THREADPARAMS structure. Prior to calling WinPostMsg, SecondThread calls DosEnterCritSec to ensure that the thread has been terminated by the time the client window procedure receives the message.

Back in ClientWndProc, the WM_BITMAP_CREATED message is processed by saving the handle to the bitmap and freeing the THREADPARAMS structure. If the bitmap handle is NULL (indicating that the bitmap could not be created) the fError variable is set to TRUE. Regardless, ClientWndProc invalidates the window to generate a WM_PAINT message.

WM_PAINT can do one of three things: If fError equals TRUE, ClientWndProc displays the text "Error occurred during bitmap creation." This

will occur if there is insufficient memory for creating the bitmap. When the program first starts up, fError is FALSE and the hbm (handle to the bitmap) variable is NULL. In this case ClientWndProc displays the message "Bitmap being created . . . ." Otherwise, ClientWndProc displays the bitmap centered in the window with a call to WinDrawBitmap.

We've now seen how a PM program can display a reasonably complex graphical image in its window by drawing the image on a bitmap in a second thread of execution. Once the bitmap is created, the window can be updated quite quickly.

THE PROBLEMS

Now, you may wonder: "Doesn't such a bitmap take up a lot of memory?" Yes, it certainly can. When running on an 8514/A, the bitmap that THREADS1 creates requires over 640K. It seems wasteful for one OS/2 program to use as much memory as was available in DOS, particularly when that memory is being used solely for updating the program's window!

> More memory means better performance. If we didn't care about performance, we could run OS/2 in 1MB and let it swap like crazy.

Yet, isn't performance what a large memory space is supposed to provide? If we didn't care about performance, we could run OS/2 in 1MB and let it swap like crazy. More memory means better performance. In the case of THREADS1, even if OS/2 swapped the bitmap to disk, swapping it back into memory would probably be faster than having the program redraw the entire image.

Memory requirements aside, there are a couple of other problems with the THREADS1 approach to drawing. One of them is psychological: if a program requires a period of time to draw a complex image, it's more fun to watch the program drawing! Moving all the drawing to the background makes the program boring.

What if THREADS1 were running on a PM system with a sophisticated video board with a fast coprocessor? And what if this video board could render the image in less than a second rather than the minute or so required on an 8514/A? In this case, the bitmap would not be necessary. Moreover, the creation of the bitmap would take just as long as it does today, because GPI would not be taking advantage of the video board's coprocessor.

But programming involves trade-offs, and THREADS1 shows how to devote a great amount of memory and some extended processing time up front to improve program performance later on. ■

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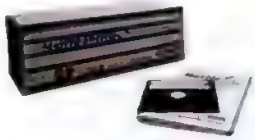

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CIRCLE 731 ON READER SERVICE CARD

by
Ray Duncan

Power Programming

A Sneak Preview Of the 32-Bit Version of OS/2: 2.0

OS/2 2.0, the long-awaited, 32-bit, 80386-specific version of the OS/2 operating system, reached developers in early January 1990. The changes and new features it includes answer virtually all the objections that critics have raised about the original 16-bit versions. But even if the technical excellence of the system can no longer reasonably be questioned, the fate of OS/2 as the successor to DOS still hangs in the balance. It remains to be seen whether OS/2 2.0 will entice enough users away from DOS to become the dominant force in the shrink-wrapped software market. If not, OS/2, like Unix, will remain a niche operating system for workstations, network servers, and power users.

In this and the next installment of Power Programming, we'll survey new features of OS/2 2.0 at several levels. Then, in succeeding columns, we'll address specific issues involved in turning existing 16-bit OS/2 applications into true 32-bit applications. The descriptions that follow apply specifically to the first beta-test version of OS/2 2.0, called Build 6.43 and dated 89/12/20. The system might have undergone significant changes even before you read this column, and I'm certain that many important aspects of OS/2 2.0 will change before its retail release, perhaps as early as the fourth quarter of 1990.

THE OS/2 2.0 SDK

The initial release of the OS/2 2.0 Software Development Kit must set some kind of record for systems-level programming tools. The original $3,000 Microsoft OS/2 1.0 SDK was a hefty beast: it arrived in a 3-foot box containing over 30 pounds of manuals and other paraphernalia. The $2,600 OS/2 2.0 SDK, by contrast, consists of only sixteen 5.25-inch 1.2 MB diskettes and a half-dozen Xeroxed sheets of installation notes; the whole weighs a grand total of ten ounces! While the folks who designed the earlier OS/2 1.0 SDK were clearly refugees from DEC's VAX VMS documentation division, I can't but wonder whether the people who put together the OS/2 2.0 SDK were recruited from a Zen monastery.

■ Virtual-86 Mode for multiple DOS Boxes that multitask and use windows, and memory management through paging highlight the new 32-bit OS/2 2.0.

Installing the SDK is a laborious process: it requires about an hour. The diskettes are divided into three groups: the operating system itself, the programming tools, and the toolkit, which includes various OS/2 API header files, libraries, utilities, and a few sample programs. Installation of the operating system proper takes about 30 minutes if everything goes well, but the installation program is rather touchy and can fail midway for any number of reasons. It took me three tries to get a working system, even though I'm a veteran who has installed more alpha, beta, and retail versions of OS/2 than I care to think about. But once the operating system is up and running, installation of the other two sets of disks is straightforward. Simply place the first disk of each set in A: and run the SETUP batch file.

After loading all the diskettes onto your hard disk, you find yourself with a mountain of on-line documentation to struggle through. The OS/2 user command reference, an overview of OS/2 2.0's new features, the kernel and Presentation Manager Application Program Interface (API) reference, the application Style Guide, and the Information Presentation Facility Compiler reference are supplied in the form of IBM Information Presentation Facility (*.INF) files. These you read with the IPF viewer (VIEW.EXE), which is a graphics-based Presentation Manager application. On the other hand, the documentation for the programming tools is supplied in the form of QuickHelp (*.HLP) files. These are accessed with the Microsoft QuickHelp utility (QH.EXE), which is a character-based application that can be run in a PM window.

In all, the OS/2 2.0 on-line documentation files add up to at least several megabytes of text. Since it isn't available in printed form, you can't study it in any organized way. When you're desperate to learn something, you must simply carom around in QuickHelp or IPF until you stumble onto the information you need. If you've got the patience, you can methodically paste the contents of each topic into a file and create your own printed documentation. Unfortunately, however, the IPF has some nasty bugs that cause it to drop words out of the pasted text, so your chances of getting a usable API reference even by this laborious route are not very good. Let's hope that Microsoft and IBM at least get all the documentation converted to a single presentation format in the next SDK 2.0 update.

The programming tools supplied with the SDK include the 80386 versions of Microsoft C, MASM, LINK, and *CodeView* 3.0, and such usual auxiliary pro-

grams as the Resource Compiler, Dialog Editor, Font Editor, Icon Editor, MARKEXE, MAKE, Microsoft Programmer's Editor, and QuickHelp. Also supplied is a debugging version of the OS/2 2.0 kernel that sends status and error messages out through the serial port. Although they generate or manipulate 32-bit object code and executables, nearly all of the programming tools are 16-bit protected-mode programs. This lets you use them for cross-development: you can maintain source code and build 32-bit applications on a tried-and-true OS/2 1.2 system and then simply move the final executables to your OS/2 2.0 system for testing.

We can all be eternally grateful that the SDK is a joint project of Microsoft and IBM, and all SDK manufacturing, shipping, and technical support is handled at a single site (Microsoft). This arrangement is far preferable to that used with the original OS/2 1.0 SDK. At that time, Microsoft and IBM apparently believed themselves to be in some sort of silly competition for the hearts and minds of OS/2 developers. So both companies released separate SDKs that were never quite in sync and whose documentation, tools, header files, and sample programs differed, sometimes subtly and sometimes wildly. As a result, many developers felt obliged to buy both versions of the OS/2 1.0 SDK in order not to miss anything. And they spent enormous amounts of time and money tracking the updates of each SDK and analyzing the differences between them. I'm relieved to see that Microsoft and IBM have decided not to repeat that fiasco.

OS/2 2.0 AND THE USER

From the user's point of view, the SDK version of OS/2 2.0 looks remarkably like that of OS/2 1.2. The installation process is virtually identical; the appearance of the Desktop Manager, File Manager, Task Switcher, icons, scroll bars, and so on are essentially unchanged; and OS/2 2.0 uncomplainingly runs all OS/2 1.2 applications—even those that use such new OS/2 1.2 features as color icons, long filenames, and extended attributes.

Of the main differences between OS/2 1.2 and 2.0, the most obvious ones relate to the DOS Compatibility Environment, or DOS Box. Unlike the 16-bit 286 versions of OS/2, which supported only a single DOS Box, OS/2 2.0 permits multiple DOS Boxes to be active simultaneously. Moreover, DOS applications may be run either in a window or full-screen, even when they are displaying graphics. Refer to Figure 1 for an example. Like protected-mode applications, the DOS Boxes themselves are now multitasked and swappable, and they continue to receive CPU cycles when they are in the background. Real-mode programs and batch files can be launched directly from the Program starter or protected-mode command-line sessions; OS/2 2.0 automatically fires up a new real-mode session on demand. The user can cut and paste text from one DOS window to another, and can cut and paste text *or* graphics from a DOS window into a PM window. OS/2 2.0 can even provide EMS memory to real-mode applications on demand, and the amount of EMS memory available to each DOS Box is under the user's control. (This prevents greedy spreadsheets from gobbling up all the physical memory and disk-swap space.)

When you run CHKDSK in an OS/2 2.0 DOS Box, you're in for a pleasant surprise. In the beta version, CHKDSK shows 624K available in each DOS Box—far more than was available in OS/2 1.2 (approximately 500K) or in any recent version of MS-DOS itself. Yet the compatibility of the DOS Boxes with DOS applications is excellent. This is because the MS-DOS emulator module loaded into each DOS Box was derived directly from the MS-DOS 4.0 source code after removing the file system and other services that must be handled by the OS/2 kernel.

OS/2 2.0 can safely multitask real-mode programs and can window their graphical displays because it exploits the special 386 subset of protected-mode operations known as Virtual 86 Mode. A DOS program running in a session called a "Virtual 86 Machine" can't detect any difference from 8086/88 real mode. It simply sees a 1MB address space and can play all the usual tricks, such as stuffing arbitrary paragraph addresses into segment registers. The operating system, however, retains a degree of control over the application that it could never exert over a program that was actually running in real mode. This lets OS/2 2.0 safely execute ill-behaved DOS applications that might crash OS/2 1.2 or that would not run in OS/2 1.2's DOS Box at all.

In Virtual 86 Mode the operating system can, if it chooses, trap some or all of the real mode application's I/O port reads and writes, the execution of sensitive instructions, and references to memory addresses outside the DOS address space (such as direct writes to the video refresh buffers). The Operating System can then decide selectively which of these operations should be allowed to proceed unchanged, which should be translated (by substituting one memory address for another, for example), and which should be carried out by the operating system on the application's behalf. The operating system can also decide to "mirror" certain interrupts into the Virtual 86 Machine. This allows an MS-DOS communications program to run under the impression that it is in complete control of the serial port, for example. This process of filtering all hardware accesses in a fashion invisible to the application is called *device virtualization*.

Figure 1: Multiple DOS applications can run simultaneously under OS/2 2.0. The applications are preemptively multitasked; their memory is swappable; and you can cut and paste text and graphics from a DOS application into a true PM application. OS/2 2.0 exploits the 386's Virtual 86 Mode, so it will run graphical DOS applications in a PM window.

OS/2 2.0 SYSTEM ARCHITECTURE

At the architectural level, Version 2.0 is an obvious descendant of its 16-bit predecessors. It supports essentially the same graphics engine, networking, multitasking, and interprocess communications facilities. It is built from the same basic components: installable device drivers and file systems, the OS/2 kernel, a host of dynamic link libraries, and the PM Shell.

However, in just as many ways OS/2 2.0 seems like a new operating system that happens to run DOS and 16-bit OS/2 applications. Many of the basic system components have been rewritten or heavily overhauled in a release of various limits on system objects and resources that were present in the 16-bit version. For example, OS/2 2.0 supports no less than 4,096 threads of execution, 4,096 processes, 32K of simultaneously open files and devices, extended attribute sets larger than 64K, and about 3,000 named pipes. It also supports a new type of executable file whose header uses the identifier LE instead of the previous NE or MZ.

The most far-reaching architectural improvement in OS/2 2.0 is its use of the 80386's paging unit for virtual memory management. Gone is the segment motion and segment swapping used in the 286 version of OS/2. Memory is always allocated and swapped in units of 4K pages. This generally improves throughput because small working sets of pages will tend to stay in memory for all active applications. A single application no longer runs the risk of having its entire code segment discarded or its entire data segment rolled out to disk just because another process asked for a few kilobytes of memory and all physical memory was already in use.

OS/2 2.0 32-bit applications are programmed in a *flat* address space model, eliminating at one stroke the plethora of memory models and runtime libraries that has plagued 16-bit 80*x*86 programming. A 32-bit application is like an MS-DOS .COM program (which used the tiny model with CS=DS=ES=SS), with the exception that the address space in which it lives is 4GB instead of 64K. Of course, since the 32-bit application is running in protected mode, all segment registers must be loaded with valid selectors. But only two selectors (and thus two descriptors) need be involved: an executable/readable selector in CS and a data read/write selector in DS, ES, FS, GS, and SS. The descriptors for these two selectors map to the same memory.

Within the 4GB segment, shown in Figure 2, the application code and data reside at the low end, and the operating system is mapped into the segment at the high end, with the application's stack(s) and local heap floating in between. Thus all calls and jumps are "near" in nature. But this in itself doesn't save memory, since most of the jumps and calls will be 5 bytes long (an opcode byte and a 32-bit offset)—the same length as a far call or far jump in 16-bit protected mode. Write-protection of code and constant data is enforced at the page-table level rather than at the segment level used by the 286 version of OS/2. This, together with the 4K granularity of memory allocation, allows 32-bit applications to play host to whole new classes of bugs unknown in 16-bit protected mode.

While the operating system and application live in the same flat address space, the operating system protects itself from the application. The memory manager sets up ring 0 and ring 3 CS and DS selectors whose descriptors differ only in their *limit* (segment length) fields. The ring 3 selectors map only the lower end of the address space, which contains application code and data, while the ring 0 selectors map everything. If the application tries to touch high memory, the result is a GP fault, but when it calls an OS/2 entry point, an automatic switch in privilege levels lets the operating system access any location in the 4GB address space.

Although the unit of memory currency is not the selector, the system deals in memory *objects* that usually act like segments. The difference is that the *handle* of an object is its 32-bit base offset, rather than a selector which cannot be arithmetically manipulated and to which an offset must be appended. The system switches addressing contexts from one application to another and arranges for memory objects to be shared by manipulating the 80386's page tables and page-table directory. Grouping of code and data into *objects* within an application at link time is controlled by the same old SEGMENT and GROUP directives. The Linker resolves all offsets to a common base by mandating the existence of a sort of supergroup—FLAT, which embraces all the memory objects in the application.

Next time, we'll pick up this overview with the OS/2 2.0 API.

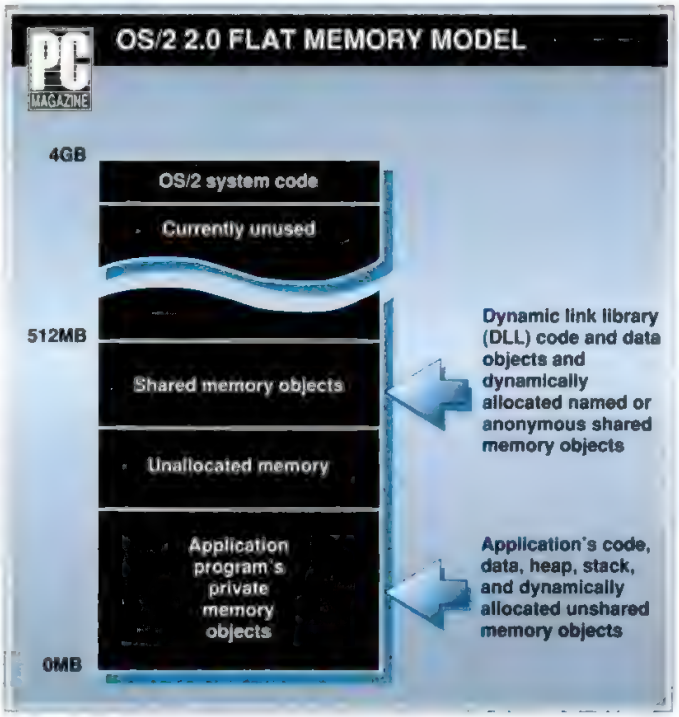

Figure 2: OS/2 2.0 applications are programmed with a flat memory model in which all offsets, calls, and jumps are near. The application and operating system are mapped into a single 4GB segment, with the application's private code, data, and memory objects at the bottom of the address space and the operating system's private code and data at the top. Shared memory objects, such as DLL code and data, are mapped in between. Note that the applications's private and shared address space is limited to 512K. This limit will be lifted in a future release of OS/2.

THE IN-BOX

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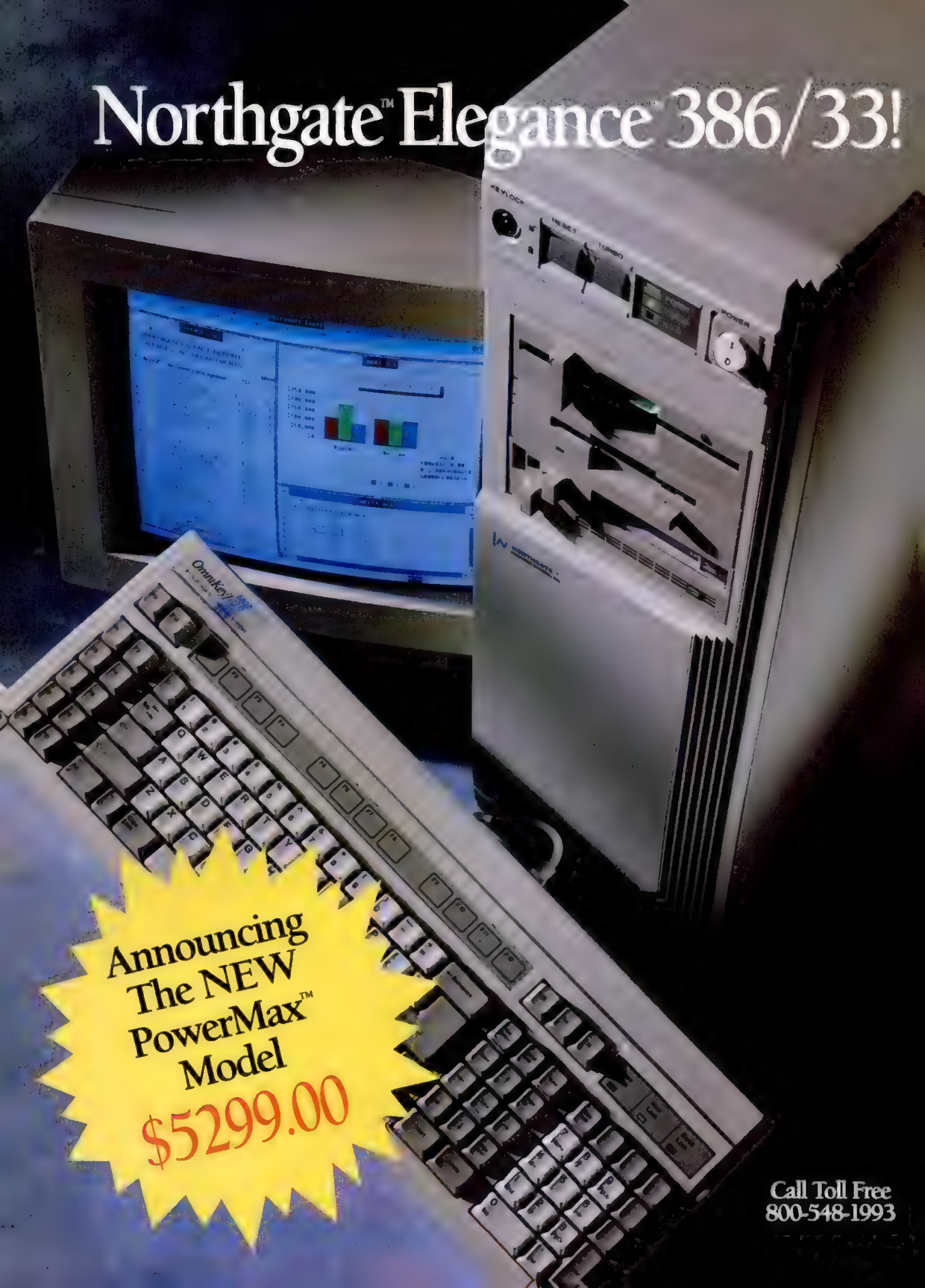
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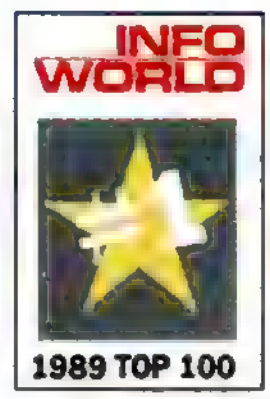

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by
William S. Hall

Windows

■ FONTS AND FONTWARE: Everything you wanted to know about fonts, and how Windows uses them.

FONTS AND FONTWARE

Tired of the same old faces on your *Microsoft Windows* screen or printer? Do you need special characters for a brochure you're designing? Are you intrigued by the strange entries under [fonts] in your WIN .INI file, baffled by acronyms such as ANSI, or perhaps simply curious about how the ancient art of typography is realized in *Windows?* If so, then read on, because this issue's column is all about how *Windows* uses fonts. We'll also take a look at Bitstream's *Fontware*, a software package that creates fonts for *Windows*.

WINDOWS FONTS

Many end users—even power users, if the truth must be known—ask me about fonts. The inquiries are often accompanied by quizzical looks and confused faces. It seems there's a lot of confusion about them—and no small wonder: with the advent of computers, the word *font* has acquired enough new meanings to confuse anyone.

A dictionary defines font as an assortment of type, all of one size and style. *Type* itself is defined as a rectangular block of wood or metal bearing a relief character from which an inked print is made.

In the computing world these definitions have been extended in many ways. Imagine, for example, that the recipient of the print is a raster scanning device such as a PC monitor. Inking is simply a matter of lighting selected pixel elements (pels). The pels to be lit for a given character are determined by a bit pattern that can be thought of as the type block; the relief consists of the bits that are on. Finally, an assortment of such patterns constitutes the font. This description defines the essence of *bitmapped* or *image* fonts. Bitmapped fonts are the obvious extension of classical printing to computing.

But, there is another way to create characters on a display device, and that's to do what people have done for centuries—draw them. Hence, instead of a bit pattern, a character is described in terms of a sequence of elementary graphics commands to actually draw the character's outline and to fill the interior. A collection of such rules is called an *outline, vector,* or *stroke* font. Arising from the days of storage-tube technology, they find wide use in plotters, PostScript printers, and phototypesetting. Unlike bitmapped fonts, which have a specific size and resolution, outline and stroke fonts can be rotated to any angle and scaled to any size. Both image and vector fonts are available in *Windows*.

Image fonts have an advantage in that they can be tailored to produce the best appearance for a given size and device. And they require less computation to display. However, a number of such fonts must be available in order to create different sizes of characters. Of course, it is possible to scale the bit patterns themselves, but quality is often lost in the process. By contrast, the very versatility of vector fonts renders them more expensive to display in terms of computing time. And their appearance on low-resolution devices or when scaled to small sizes is worse than can be achieved manually.

CHARACTER SETS

A font includes a given set of symbols, called a character set. The most widely known character set is basic ASCII. Consisting of 94 glyphs (characters), a space, and 33 control codes, ASCII includes the letters of the English alphabet in both lower- and uppercase, punctuation marks, symbols, numerals, and diacritical marks. No glyphs are associated with the control codes, whose values encompass 0 to 31 and 127. The space "character" has a value of 32, and the rest of the so-called printable characters range in value from 33 to 126. Basic ASCII is called a 7-bit character set since a maximum of 7 bits of information is required to represent any single element.

An extension, called Business ASCII by Bitstream, adds additional symbols and punctuation in the range of 161 to 175 and adds an extra space character at 160. The values from 128 to 159 are reserved for 8-bit controls, which are needed by such terminals as the DEC VT220. Business ASCII is an example of an 8-bit character set, since those values above 127 require 8 bits to represent them.

Your personal computer's ROM contains an 8-bit character set developed by IBM, which has a glyph for every value except 0 and 255. Containing basic ASCII as a subset, the 8-bit positions contain a subset of letters from Western European languages requiring diacritical marks, symbols, some mathematical signs, and a collection of graphics characters.

In *Windows*, this character set is realized in a collection of files known as OEM (original equipment manufacturer) fonts. OEM character sets vary according to the keyboard type and country.

In *Windows* 2.*x* these fonts are found in files usually named FONTXXYY.FON. The XX will be either LO, HI, or SQ, and are optimized for the CGA, EGA, and VGA displays, respectively. YY stands for a particular kind of keyboard: NO for Nordic, PO for Portuguese, ES for Extended Spanish, and so on.

Windows requires the OEM font only when running a standard application in a window. To see it, just execute COMMAND.COM from *Windows*. *Windows/386* has an additional special set of OEM fonts called EGA40.FON, EGA80.FON and so on to handle old applications.

All fonts that appear in *Windows* applications use a character set called *Windows ANSI*. Again, an 8-bit character set including ASCII, ANSI contains enough charac-

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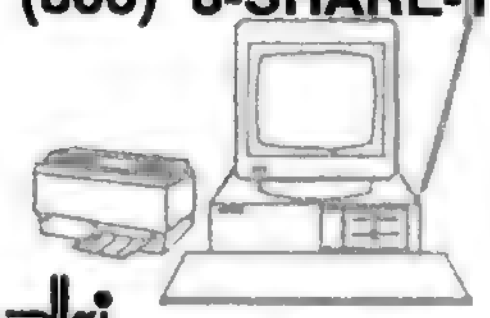

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ters in the range of 160 to 255 to render the major Western European languages when used with an appropriate keyboard driver. *Windows ANSI* cannot be used with many Eastern European languages, even those based on the Roman alphabet, because a number of letters with diacritical marks are missing.

Other character sets arise from printer technology. For example, several have been defined by Hewlett-Packard for their LaserJet printers and include HP Roman 8, Linedraw, Math, and Pi.

TYPEFACES AND STYLES

A font usually uses a specific design, called a typeface. The Speedball Textbook for Pen and Brush Lettering (by Ross F. George, 19th edition, 1965) recognizes three basic groups: Roman, Gothic, and Text. Characters composed of thick and thin elements are called Roman. Gothic letters are composed of uniform width elements. Angular letters such as Old English and Old German are examples from the Text group, although others tend to regard them as Gothic. Any of these groups may be made into a serif font by adding a small line at an angle to the upper and lower ends of the strokes of a letter.

The beautiful Roman letter evolved from the Greek form. Written by reed pens held at a constant angle, the wide/narrow strokes were produced naturally. Roman builders added the serifs when the letters were applied to inscriptions on the famous Roman arches. Endless variations exist today. One of its most popular forms, Times Roman, was developed (and copyrighted) by the *Times* of London newspaper.

The Helvetica typeface provides a pleasing example of sans serif letters of uniform width. The Helvetii were a Celtic people inhabiting Western Switzerland in the Roman era. This may explain why such fonts are alternatively known as Swiss fonts.

Any font can be written in various styles, such as italics where the letters are slanted at about a 15-degree angle. Other styles include bold, underlined, and strikeover. They can be combined to produce a bold underlined italic font. *Windows* can synthesize each of these types.

A font can be either fixed-pitch or proportionally spaced. The first case is typical of typewriters, some printers, and video terminals. Each character has the same width. If a font is proportional, the width can vary from letter to letter. A font can also designate kerning pairs. These are pairs of letters that, because of their relative shapes, can be placed closer to each other than their normal intercharacter spacing. The pairs AW and VA serve as examples of this spacing.

WINDOWS-SUPPLIED FONTS

The image fonts provided under *Windows* 2.0 can be classified as *typographic* or *system*, according to usage. The typographic fonts are used primarily by word processing, drawing, and desktop publishing applications such as *Windows Write*, *Ami*, and *PageMaker*. The typefaces include Times Roman (TMRSX.FON), Helvetica (HELVX.FON), and a fixed-pitch typewriter font called Courier (COURX-.FON). In each case, the last letter in the filename signifies the device type for which the font was designed.

A fonts are for low-resolution displays such as the CGA. *B* fonts are designed for medium resolutions such as provided by the EGA and Hercules video cards. Fonts such as TMRSE.FON work well on the VGA. Fonts whose last letter is *D* are made for the Epson class of printers in portrait mode, whereas the *C* fonts work best in landscape mode.

For displaying menus, dialog boxes, window titles, and the like, *Windows* 2.*x* uses the system font, which is currently a fairly bold fixed-pitch font using a sans serif, modern typeface and the ANSI character set. Hopefully, this will be changed to a proportional font in a future release of *Windows*. Such a change may sound trivial, but check out the appearance of OS/2's *Presentation Manager*. The superior look of PM windows is due in no small part to the proportional font used.

Windows' system fonts have the name FONTXX.FON, where XX can be LO (CGA), HI (EGA), or SQ (VGA). You won't see this font file after you've run Setup, because it gets absorbed, as does the corresponding OEM font, into one of the WIN200 files.

An image font file in *Windows* is actually an executable file having a single empty code segment that has been assembled and linked into an equally empty executable to which one or more .FNT files have been attached. Each .FNT file consists of a header data structure followed by the bit patterns for the various characters.

The .FNT files are added as resources

to the executable. When the font is installed by the *Windows* control panel or during Setup, a notation is made in the [fonts] section of WIN.INI in the form keystring=valstring. The keystring describes the font and the valstring names the file in which it can be found. When *Windows* runs, the strings are read, and enough of the .FON file (224 bytes for each .FNT file contained therein) is loaded to be able to find the rest of the font if an application needs it. Clearly, you can save some memory space by installing fewer fonts but at the price of reduced capability.

The standard *Windows* fonts provide sizes of 8, 10, 12, 14, 18, and 24 points, a point being 1/72 of an inch. Depending on the display on which the font was digitized, the height and width, in bits, will vary. None of the *Windows* fonts have any specific type, since all can be synthesized. However, products such as *Fontware* can make separate characters that may look better than the synthesized ones.

Windows also supplies three vector fonts called ROMAN, SCRIPT, and MODERN. These are actually OEM fonts but use the ANSI character set. I don't know enough of their organization to describe them in detail.

Here is a tip for *Windows* 2.*x* users: You can store your fonts in another directory if it is named in your path. You can also use the DOS APPEND command to point to their location. This can reduce clutter in your *Windows* directory.

HOW WINDOWS USES THE FONTS

Let us suppose you have a dot matrix printer such as an Epson FX-100 as your primary printer. Using *Windows Write*, load and print that perennial favorite PRACTICE.WRI, which comes with your *Windows* distribution disks. When you print it, note that you get a rather good rendering of the Helvetica and Courier fonts used in the document. If you happen to change one of the paragraphs to Times Roman, that comes out fairly well, too. How is this possible, since such fonts are not built into the printer?

What happens is that the fonts you see on the screen are those designed for the display. But when printing occurs, your document (or part of it) is composed again, this time in memory, using the fonts which are appropriate for the printing device's resolution and aspect ratio. The result is then sent to the printer as a graphics image. The process is repeated until the end of the document is reached.

Now try an experiment. Using the Control Panel, remove HELVD.FON from *Windows'* list of fonts. (However, don't delete the file!) And then print the file again. You'll find that it won't look nearly as nice. What happened is that when you deleted the D font, you removed the font providing the best available match to the characteristics of the printer. *Windows* must then create a font from the remaining ones available and the quality may drop if the match is not a good one.

If you print WIN.INI from Notepad, no attempt is made to match the font you see on the display. Instead the text is transferred directly to the printer, which then uses its own internal fonts.

EXPANDING AVAILABLE FONTS

The discussion above illustrates why *Windows* becomes a less-useful tool for quality text processing if your font set doesn't match the requirements of your output devices. A really good example is provided by some Toshiba printers with resolutions of 180 dots per inch horizontally and 60 vertically. When a columnist for the now defunct *Sextant* magazine lamented the poor quality of his Toshiba's output, I suggested that he try creating new printer fonts using Bitstream's *Fontware* package. The results were a great improvement.

You may want to generate new fonts for many other reasons. An obvious one is to obtain access to a wide variety of typefaces; in one of Bitstream's recent catalogs I counted over 50 faces, including classic typewriter, a variety of Roman, Gothic, Modern, and numerous special-purpose types. Most support italic, bold, and bold italic styles.

If you're fortunate enough to have a PCL printer capable of supporting soft fonts, you can greatly increase the variety of fonts over those contained in font cartridges. Finally, you may need a special character set; in the latest version of *Fontware*, a limited customized set can be created.

There is good news for *Microsoft Excel* users. Bitstream is currently providing a $25 starter kit specifically for *Excel*, though anyone can purchase it. For this price, you get *Fontware*, Version 3.0, and two typefaces, Swiss and Dutch, which sets you up with the basic Gothic and Roman categories. Each can be used to gener-

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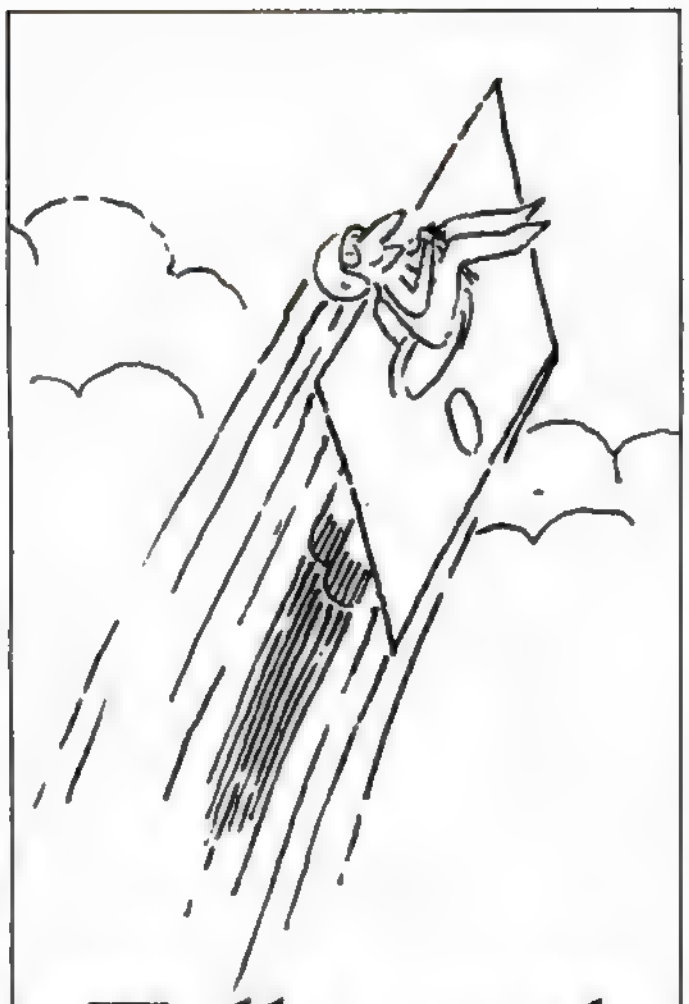

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ate fonts of any size (including decimal increments) up to certain specified maximums that depend on your printer and display. Styles include italic, bold, and bold italic. Support in the starter kit is not provided for PostScript outline fonts.

Additional typefaces can be purchased for about $180 each from Bitstream or for considerably less from dealers. Even so, building up an extensive library of different fonts can be expensive, but the results are usually worth it.

Font generation is a slow process involving quite a great deal of real-number calculation. Hence, if you use *Fontware* frequently, you may want to install a floating-point chip such as an 80287 or 80387 in your machine. Since many 386 computers can also use the 80287, which is quite adequate—and much cheaper—this may provide the best compromise of speed and price.

I've found the quality of such fonts to be fairly good. It can be useful to produce sizes not provided by the standard *Windows* selections. This is especially true for the larger fonts, frequently generated in *Windows* simply by doubling the width or height of some smaller font, and always resulting in an unacceptable loss of quality. By creating fonts of the required size, you can greatly improve the appearance of your documents. I especially like being able to produce downloadable fonts for a PCL printer to increase its versatility.

CUSTOM CHARACTERS

Finally, let me mention one other powerful feature of *Fontware*—the capability to create customized character sets. The current version provides a tool to generate a typeface containing up to 94 characters. One use is to create a large, headline font containing only a few characters. Large fonts can use a lot of computer memory, so it is advantageous to limit the number of characters to those needed.

The elements of a customized font can be chosen from the Bitstream International Character Set (BICS), which has some 560 characters. I decided to test this capability by putting together a font that would contain the letters with diacritical marks of the main Western Slavic languages (Czech, Polish, and Slovak). I also wanted to have standard ASCII, so the best approach seemed to try to replace the last 64 characters in the *Windows* ANSI set with my choices. Since *Fontware*'s tools for customized fonts is limited, it was necessary to examine some of the files in the CSD subdirectory, where the character sets are defined.

It turns out that the .CSD files are simply text files. First I used *Fontware* to create a customized character set containing the ASCII character set. Then, with my text editor I edited the corresponding .CSD file. Since the file consists mainly of a column of paired figures of the form *XX:YY*, it was not hard to figure out that the first number is the position in the character set and the second the BICS index. By adding the necessary pairings, I was able to construct a font containing all but one of the special characters I wanted: the Slovak *ŕ* with an acute accent (long r).

Finally, I made and tested the font for both printer and display using the two typefaces supplied with the starter kit. I also created standard *Windows* ANSI fonts. Generally, the characters in the ASCII range (32 to 127) were well formed. But, as I expected, the high-order ones did not fare so well.

Accents on some of the capital letters were either missing (the umlaut) or indistinguishable. Such errors might be minimized if the font has internal leading, which is the region reserved for diacritical marks. In the supplied typefaces, those characters having accents above are simply made smaller than their unaccented companions, resulting in further reduction of the quality of these letters. Hence, you may need to correct your font. In the future I'll report on tools to do this.

Before we close, here's a tip from frequent contributor Barry Simon:

Tired of seeing the Microsoft logo everytime you start *Windows?* Here's how to make it go away. Hit the Spacebar after typing the command `win` and then hit Enter and no logo will appear. This will work in a batch file, although your editor may trim trailing spaces. If it does, use the command `win > nul` instead.

OPENING WINDOWS

Share your experiences with the *Windows* environment. We'll pay you $50 for any tips we print. Please send your letter on a disk along with a printout. Mail your contributions to Windows, *PC Magazine*, One Park Avenue, New York, NY 10016, or upload them to PC MagNet (see the "By Modem" sidebar in the Utilities column). ■

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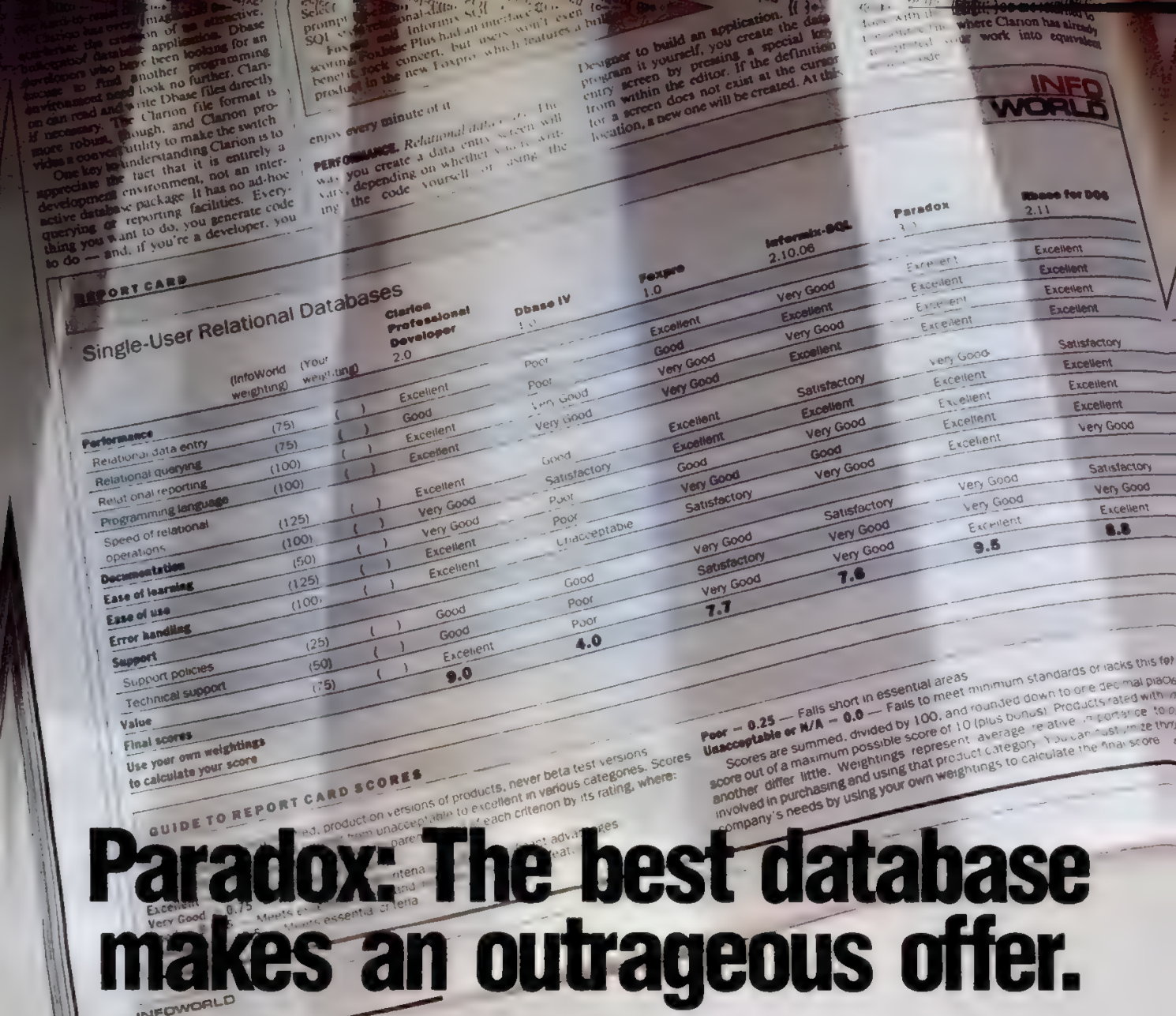

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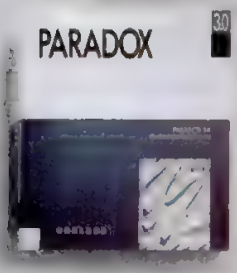

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edited by
Trudy Neuhaus

Databases

PARAVIEW, A PARADOX ENGINE APPLICATION

Do you ever wish you could view a database file from the DOS prompt? Maybe even move around and edit a record or two? With PARAVIEW, you can. Or more to the point, with the *Paradox Engine*, you can now add this kind of powerful functionality to your database applications or create standalone productivity tools.

We talked about the *Paradox Engine* last time. PARAVIEW.EXE lets you see it in action. Composed of about 800 lines of C code (most of which are for managing screen and user input), PARAVIEW uses the *Paradox Engine* to read, display, and update table records, as well as let you move around the tables on-screen. And while the program doesn't come close to using all the functions in the *Engine* library, it does provide an excellent example of what's involved in using the *Paradox Engine*.

In recent months, the source code for programs hasn't always appeared in the magazine so that we can publish more columns that provide tips to help you work smarter. However, in this issue we've made room for PARAVIEW. We'll print future programs whenever we can make room. As always, you can download copies of PARAVIEW.EXE and its source code from PC MagNet. Instructions for downloading are in the "By Modem" sidebar in the Utilities column.

■ **PARAVIEW, A PARADOX ENGINE APPLICATION:** The hardest part is getting started. This utility sets the stage for adding functionality to your database applications using C libraries such as the Paradox Engine.

USING PARAVIEW

PARAVIEW is a utility that lets you interactively display and edit any *Paradox* table. The syntax is

```
PARAVIEW <tablename> [buffersize]
```

where *tablename* is the name of the *Paradox* table you want to display and edit, and *buffersize* is an optional parameter that sets the size (in kilobytes) of the *Engine*'s table buffers. The buffersize can be any value from 8 to 255. If you provide a number outside this range or do not choose to use this parameter, the program will use a default of 32. The more memory you have available, the greater the buffersize should be, as this will generally improve its performance.

Enter this syntax at the DOS prompt and PARAVIEW will open the table you specify and display it on-screen. As shown in Figure 1, the PARAVIEW screen imitates a spreadsheet, displaying the name of each field across the top of the screen, and listing up to 23 rows of a table per screen. The last row on the screen is reserved for the record number, error messages, and user information.

Several keys help you navigate a table once it's displayed, and most operate as you'd expect them to. Home brings you to the beginning of a table, and End takes you to the end of the file; PgDn displays the next 23 rows while PgUp displays the previous 23 rows; to move up or down the table one row at a time, use the Up and Down Arrow keys; hitting Tab, Right Arrow *or* Enter will move the cursor to the right one column at a time; and Shift-Tab and Left Arrow move it back in the same fashion.

You can also use PARAVIEW to edit a table. Use the Backspace key to delete the character to the left of the cursor in any field. To enter data in a field (assuming the field is not full), just hit the appropriate keys. Your entries will be saved when you exit the program. Pressing the Del key will delete the current row. Finally, pressing the Esc key at any time will cause PARAVIEW to save your changes, close the table, and exit to DOS.

PARAVIEW consists of several components, each of which provide distinct services to the program as a whole and make it fast, efficient, and easy to maintain. Let's take a look at these now. The source code for PARAVIEW is listed in

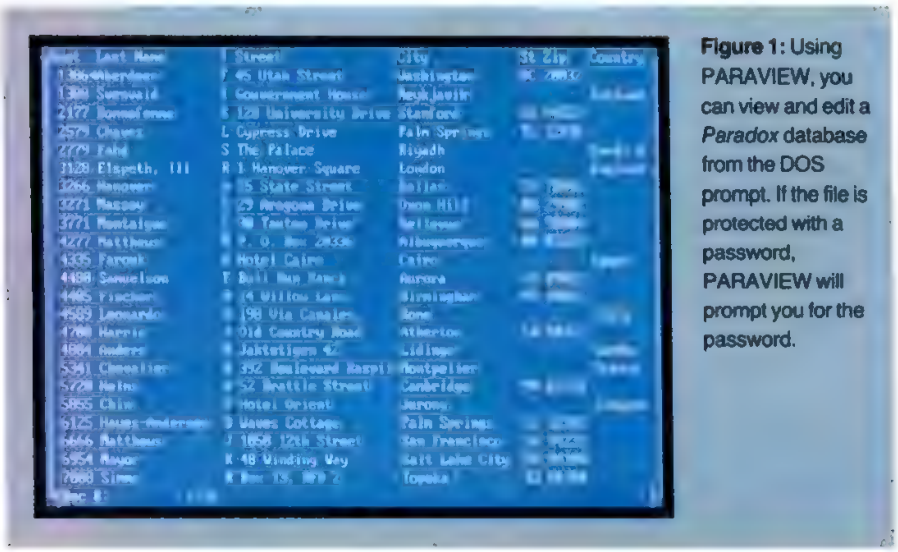

Figure 1: Using PARAVIEW, you can view and edit a *Paradox* database from the DOS prompt. If the file is protected with a password, PARAVIEW will prompt you for the password.

Figures 2 through 4, so you can reference it as we discuss it.

THE KEYSTROKE INTERFACE

A keystroke interface retrieves and identifies important keys—in particular, function and editing keys used by the program. When you press a key, PARAVIEW uses the standard C-library function getch to retrieve that key. However, PARAVIEW must be able to tell if that key is an ordinary ASCII key (A through Z, 0 to 9, Tab, Esc, Backspace and Enter) or a navigational key (PgUp, PgDn, Home, End, and so on). To distinguish between the two, getch returns a zero when a navigational key (which has no ASCII equivalent) is pressed, and the next call to getch returns the key's Scan code. This process is encapsulated in the getkey function, which (when it encounters a Scan code) sets the 8th bit (0 to 100) in the key value so that it can be distinguished during the rest of the program.

The SCANCODE macro

```
#define SCANCODE(key)  (key | 0x100)
```

is used to set this bit and to create macros from the Scan codes of the navigational keys. Thus, HOME can be defined as

```
#define HOME   SCANCODE(71)
```

where the value 71 is the Scan code for the Home key.

SCREEN AND TABLE ROW MANAGEMENT

PARAVIEW distinguishes between major and minor screen updates. Major screen updates are required when one or more screen rows move or change (such as when you jump from one part of a table to another using Home, End, PgUp or PgDn). A minor screen update is required to change the content of a field, or move the cursor.

To speed up major screen updates, PARAVIEW uses a screen-display buffer, which corresponds to the physical screen (including both a character and an attribute byte for each screen location). Thus, a number of rows can be written to the display buffer, then copied *en masse* to the physical screen.

Most of this updating work is done by the function atsayb, which allows the calling function to specify the row-column coordinates where the data will appear on the screen. Since the function takes a variable argument list, you can use it like the printf function to format data on the display. The atsayb function uses another function, putsb, to place the data at the appropriate offsets in the display buffer. The putsb function in turn places the data into the display buffer while keeping the attribute bytes intact. When the program is ready to update the physical screen from the display buffer, it can use Scrrefresh, a macro for the Turbo C puttext function. Scrrefresh will write the entire display buffer to the physical screen.

> With PARAVIEW, many rows of data can be written to the display buffer, and then copied *en masse* to the screen.

The atsayb function takes one additional parameter: the offset into the formatted data from which to begin writing to the display buffer. This parameter is zero for all calls to atsayb to format the column headers and borders. But PARAVIEW can use this to pass an offset into the displayed table rows and cause the screen to effectively pan left and right. Since atsayb formats the data into a local buffer, it inserts a NULL terminator into the buffer at one screen width from the display offset previously mentioned, so it cannot write to more than one screen row at a time.

Minor screen updates (where only a single byte is written) are done by placing the byte on the screen with atsay (similar to atsayb, only it doesn't require an update of the entire screen), and simultaneously placing the byte in the display buffer.

To manage the relationship between the rows displayed on the screen and their associated records in the table, PARAVIEW uses a set of character arrays—one per record displayed on the screen. Since it can display up to 23 records from a *Paradox* table at a time, 23 buffers are available to contain the contents of each database row. These buffers can be quite large—up to 4,000 bytes each, which is the maximum length for a *Paradox* table. Since the *Engine* uses the large memory model, allocating 92K should not be a problem (even though PARAVIEW is a little over 100K in size). PARAVIEW uses atsayb to write these row buffers to the display buffer.

The row buffers made it easy to add the database navigation keys. For example, the Home key becomes "go to the beginning of the table, refresh the row buffers from the table, and redisplay the screen from the buffers." PgDn becomes "go to the last record displayed, skip to the next record, and refresh/redisplay from there."

The Up and Down Arrow keys are slightly special cases, but they are easily solved with the row-buffer mechanism. If you press Up Arrow and the cursor is already at the top of the display, PARAVIEW has only to rotate the row buffers using the rotatebuffers function (so that the contents of each buffer is shifted downward) and read the new record into the first buffer. Since the buffers are implemented as pointers, the program simply shifts the pointers—a trivial task.

Adding an editing interface to PARAVIEW was also made easier with the row-buffer mechanism. Each field's offset into the row buffer is maintained in a table. So as you make a single change to a field (by inserting or deleting a character), the change is also made to the appropriate offset in the row buffer, and then to the screen.

DATA STRUCTURES

All of this (with the exception of the keyboard interface) was simplified by the use of two key data structures, implemented as new data types. The FIELD type contains the field name, field type, displayed field length, and the field's row-buffer offset. The RECORD type contains a pointer to the row buffer and the associated record number. The RECORDs and their buffers are implemented as an array of pointers (allocated at runtime).

The FIELDs are also implemented as an array of pointers, but they are allocated by the pxreadstructure function which initializes them by reading the table's structure. The FIELD array is extremely useful during the remainder of the program for supplying the offset of each field in each row buffer and providing the field's type.

HOW IT WORKS

Generally, PARAVIEW is a simple program. You pass the name of a table you

want to display as a command-line argument and the program then opens the file, displays its contents, and lets you navigate the table or edit the contents of individual fields. Once you press Esc, the program updates the current record if it's been changed, closes the table, and exits to DOS. Most of PARAVIEW's work, therefore, involves waiting for and responding to your key commands once they are received.

PARAVIEW begins by initalizing the *Paradox Engine* and opening the table you requested, as well as the table's data structures. The program checks to see if the table is password-protected using the PXTblProtected function, prompts you for a password if required, and clears the password with the *Paradox Engine* via PXPswAdd. After opening the table with PXTblOpen, it queries the *Engine* for the number of records in the table, and the number of fields in the record structure using the PXTblNRecs and PXRecNFlds functions, respectively. Then, PARAVIEW reads the record structure of the table.

The *Engine* does not have any built-in means of reading the structure of a table. So a program like PARAVIEW (which must generically read the structure of any table) needs to individually retrieve the name, type, and size of each field to build its display. This is done using the pxreadstructure function.

This function uses the FIELDs array to store the structure of the table being edited. After allocating the FIELDs array, it calls PXFldName and PXFldType to retrieve each field's name and type. The function uses a field handle for each field (the field handles begin with one and continue as consecutive values for each field). This function also uses the displayed maximum size of each field as the field's length, and accumulates the field lengths into a record-size value used later in the program. The only exception is Alpha fields, where the field length is stored in the structure with the field's type identifier.

Once the *Paradox Engine* has been initialized and the table structure read, PARAVIEW saves your currently displayed screen (in the Screen function), and creates a new screen display (in Scrcreate). The program uses the field names to build a header display with the buildheaderdisplay function. You should note that although PARAVIEW makes several calls to atsayb to display the screen and header displays, they are not actually written to the screen until the Scrrefresh macro is called. This process allows these direct screen writes to be accumulated, buffered, and written at once.

As a further initialization step, PARAVIEW calls PXRecBufOpen to open a record-transfer buffer on the table. Then it skips to the first record in the table with PXRecFirst and allocates the RECORD array and record-row buffers. Now it's ready to read the first screenful of rows from the table.

READING AND DISPLAYING TABLE ROWS

PARAVIEW uses a single function, pxread, for reading the contents of a table row (or record) and obtaining the record's number from the *Paradox Engine*. This function uses PXRecGet and PXRecNum to obtain the needed information from the *Engine*, and then calls pxbuildrecdisplay to read each field and format the entire row

PV.C 1 of 4

```c
/* pv.c RHS 1/22/90
 *
 */
#include<stdio.h>
#include<conio.h>
#include<alloc.h>
#include<dos.h>
#include<stdlib.h>
#include<string.h>
#include"pxengine.h"
#include"paraview.h"

/* global data */

FIELD *fields;
int recsize, current, bufblanks, numfields = 0, currfield = 0;
int maxrecs = 0, dispoffset = 0, is_modified = FALSE;
int lastrow = 0, lastcol = 0, curscol = 0;
char *curptr;

RECORDNUMBER numrecs = 0L;

char *hdrbuf;
char fldbuf[MAXFIELDLEN+1];

RECORD *recs[MAXRECS];

char screen[80*25*2];   /* screen buffer */
char *scrptr;           /* screen buffer pointer */
TABLEHANDLE tblhdl;
RECORDHANDLE rechdl;

int main(int argc, char **argv)
    {
    int i, retcode, key, bufsize = 0, protected;
    char password[MAXPSWLEN+1];
    extern int errset;

    if(argc < 2)   /* check for table name */
        {
        printf("Usage: ParaView <tablename> [buffersize (0 - 256)]"
               "\nby Richard Hale Shaw,"
               " Copyright (c) 1990 Ziff Communications\n");
        exit(0);
        }
    else
        printf("ParaView by Richard Hale Shaw"
               "\nCopyright (c) 1990, Ziff Communications Co.\n");

    if(argc > 2)
        bufsize = atoi(argv[2]);

    if(bufsize < 0 || bufsize > 256)
        bufsize = 32;

        /* set buffer size  */
    PXSetDefaults(bufsize,2,2,PXDEFAULT,PXDEFAULT,DEFSORTORDER);

    if((retcode = PXInit()) == 0)       /* initialize Engine*/
        {                               /* check for password */
        if((retcode = PXTblProtected(argv[1],&protected)) != 0)
            return ErrMsg("Table protection",retcode);
        if(protected)
            {
            int pslength = 0;
            printf("Table is password protected, Enter password: ");
            while(pslength < MAXPSWLEN) /* get password     */
                {
                key = getkey();
                if(key == ENTER)
                    break;
                password[pslength++] = (char)key;
                }
            password[pslength] = '\0';
            printf("\n");
            if((retcode = PXPswAdd(password)) != 0)
                return ErrMsg("Password submitted",retcode);
            }
                                /* open the table   */
        if((retcode = PXTblOpen(argv[1],&tblhdl,0,0)) == 0)
                                /* get # of records */
            if((retcode = PXTblNRecs(tblhdl,&numrecs)) == 0)
                                /* get # of fields  */
                if((retcode = PXRecNFlds(tblhdl,&numfields)) == 0)
                                /* read structure   */
                    retcode = pxreadstructure(tblhdl,numfields,
                        &fields);
        }
    bufblanks = (recsize < 79) ? recsize : 79;
    if(retcode)
        return ErrMsg("Initialization",retcode);

    Screen(SAVE);
    Scrcreate(0,0,24,79,WHITE,BLUE);

        /* build record header */
    buildheaderdisplay(numfields,fields);
    atsayb(0,1,dispoffset,hdrbuf);
                                /* open rec buffer  */
    if((retcode = PXRecBufOpen(tblhdl,&rechdl)) == 0)
                                /* goto top of table*/
        retcode = PXRecFirst(tblhdl);

    if(retcode)
        return ErrMsg("Opening table",retcode);

    {
    int count;
    for(count = 0; count < MAXRECS; count++)
        /* allocate record buffers  */
        {
        if((recs[count] = malloc(sizeof(RECORD))) == NULL)
            return printf("Error allocating RECORD\n");

        if((recs[count]->buf = malloc(recsize+1)) == NULL)
```

Figure 2: This C listing contains all the Engine-specific code.

PV.C 2 of 4

```
            return printf("Error allocating record buffer\n");
        }
    }

    maxrecs = (numrecs > MAXRECS) ? MAXRECS : numrecs;

    pxreread();                             /* read records */
    pxredisplay();                          /* display in buffer */
    pxrefresh();                            /* display buffer   */

    cursor(TRUE);
    key = 0;

    while(TRUE)                             /* main edit loop   */
        {
        key = getkey();
        if(errset)
            ScrErrMsg("",0);

        switch(key)
            {
            case ESC:
                break;

            case HOME:
            case END:
            case PGUP:
            case PGDN:
            case UP:
            case DOWN:
                displayer(key);             /* navigate table   */
                break;

            case ENTER:
            case LEFT:
            case RIGHT:
            case TAB:
            case SHIFTTAB:
            case DEL:
            case INSERT:
            default:
                editor(key);                /* edit table       */
                break;
            }
        if(key == ESC)
            break;
        }


    if(is_modified)                         /* if table modified*/
        {
        pxupdate();                         /* update it        */
        is_modified = FALSE;
        }

                                            /* close the buffer */
    if((retcode = PXRecBufClose(rechdl)) == 0)
                                            /* close the table  */
        if((retcode = PXTblClose(tblhdl)) == 0)
            retcode = PXExit();             /* terminate Engine */
    if(retcode)
        ScrErrMsg("Termination",retcode);
    Screen(RESTORE);
    }


/* processes left-right redisplay keys and editing keys   */
void editor(int key)
{
int adjust = 0, blank = TRUE;

if(numrecs < 1L && key != INSERT)
    return;

switch(key)
    {
    case ENTER:
    case TAB:
    case RIGHT:
        if(currfield < numfields-1)   /* fields beyond?? */
            {
            currfield++;
            adjust = (fields[currfield].flddispoffset +
                      fields[currfield].flddispsize) -
                      (dispoffset+79) + 2;
            if(adjust > 0)
                {
                dispoffset =
                    (fields[currfield].flddispoffset +
                    fields[currfield].flddispsize) + 2 - 79;
                pxredisplay();
                pxrefresh();
                blank = FALSE;
                }
            }
        cursor(blank);
        break;

    case SHIFTTAB:
    case LEFT:
        if(currfield > 0)       /* fields to the left? */
            {
            currfield--;
            adjust = fields[currfield].flddispoffset -
                dispoffset;
            if(adjust < 0)
                {
                dispoffset = fields[currfield].flddispoffset;
                pxredisplay();
                pxrefresh();
                blank = FALSE;
                }
            }
        cursor(blank);
        break;

    default:
        edit(key);
        return;
        }
    return;
    }

/* processes INSERT, DELETE and input keys  */
void edit(int key)
    {
    FIELD *f = &fields[currfield];
    char temp[MAXFIELDLEN+1];
    RECORD *p;

     switch(key)
        {
        case DEL:
            is_modified = TRUE;
            PXRecDelete(tblhdl);                /* delete record*/
            numrecs--;
            if(maxrecs < MAXRECS)
                {
                pxblank(recs[maxrecs-1]);
                atsayb(maxrecs,1,0,"%s",recs[maxrecs-1]->buf);
                maxrecs--;
                }
            if(numrecs > 0L)
                {
                int count;
                for(count = current; current; current--)
                    PXRecPrev(tblhdl);
                pxreread();
                pxredisplay();
                current = count;
                if(current >= maxrecs)
                    current = maxrecs-1;
                PXRecGoto(tblhdl,recs[current]->recno);
                }
            pxrefresh();
            cursor(FALSE);
            break;

        case INSERT:
            is_modified = TRUE;
        {
            int err;

            if((err = PXRecBufEmpty(rechdl)) != 0)/* empty buffer */
                {
                ScrErrMsg("Insert",err);
                break;
                }
            if((err = PXRecInsert(tblhdl,rechdl)) != 0)/* insert */
                {
                ScrErrMsg("Insert",err);
                break;
                }
        }
            numrecs++;
            if(maxrecs < MAXRECS)
                maxrecs++;
        {
            int count;
            for( count = current; current; current--)
                PXRecPrev(tblhdl);
            pxreread();
            pxredisplay();
            current = count;
            PXRecGoto(tblhdl,recs[current]->recno);
        }
            pxrefresh();
            cursor(TRUE);
            break;

        default:                                /* other keys */
            if((key == BACKSPACE) &&
                (curptr > &recs[current]->buf[f->flddispoffset]))
                {
                is_modified = TRUE;
                *(--curptr) = ' ';
                curscol++;
                }
            else if(curptr <
                &recs[current]->buf[f->flddispoffset+f->flddispsize])
                {
                is_modified = TRUE;
                *curptr++ = key;
                curscol--;
                }
            if(is_modified)
                {
                strncpy(temp,&recs[current]->buf[f->flddispoffset],
                    f->flddispsize);
                temp[f->flddispsize] = '\0';
                atsay(lastrow,lastcol-f->flddispsize,temp);
                curpos();
                }
            break;
        }
    }


/* processes table navigation keys  */
void displayer(int key)
    {
    int retcode;

    if(is_modified)
        {
        pxupdate();
        is_modified = FALSE;
        }

    if(numrecs < 1L)
        return;

    switch(key)
        {
        case HOME:                  /* goto top of file, redisplay */
            if(numrecs > maxrecs)
                {
                PXRecFirst(tblhdl);             /* top of file  */
```

```
                pxreread();
                pxredisplay();
                }
            else
                PXRecGoto(tblhdl,recs[0]->recno);
            current = 0;
            break;

        case END:                       /* goto end of file, redisplay */
            if(numrecs > maxrecs)
                {
                int count;

                PXRecLast(tblhdl);              /* bottom of file */
                pushrec();
                for( count = 0; count < maxrecs-1; count++)
                    if(PXRecPrev(tblhdl))
                        break;
                pxreread();
                pxredisplay();
                poprec();
                }
            else
                PXRecGoto(tblhdl,recs[maxrecs-1]->recno);
            current = maxrecs-1;
            break;

        case PGUP:                      /* goto previous group  */
                                        /* first record on-screen */
            if((retcode = PXRecGoto(tblhdl,recs[0]->recno)) != 0)
                ScrErrMsg("PGUP",retcode);
            if(numrecs > maxrecs)
                {
                int count;
                                        /* back up      */
                for(count = 0; count < maxrecs; count++)
                    if(PXRecPrev(tblhdl))
                        break;
                pxreread();
                pxredisplay();
                }
            current = 0;
            break;

        case PGDN:  /* goto next group      */
            PXRecGoto(tblhdl,recs[maxrecs-1]->recno);
            if(numrecs > maxrecs)
                {
                PXRecNext(tblhdl);
                pxreread();
                pxredisplay();
                }
            else
                current = maxrecs-1;
            break;

        case UP:
            if(current > 0)             /* if in same group */
                {
                current--;
                PXRecPrev(tblhdl);
                }
            else if(numrecs > maxrecs)
                {
                if(!PXRecPrev(tblhdl))
                    {
                    rotatebuffers(SHIFTDOWN);
                    pxread(current);
                    }
                }
            pxredisplay();
            break;

        case DOWN:
            if(current < maxrecs-1)     /* if in same group */
                {
                if(recs[current+1]->recno > 0L)
                    {
                    current++;
                    PXRecNext(tblhdl);
                    }
                }
            else if(numrecs > maxrecs)
                {
                if(!PXRecNext(tblhdl))
                    {
                    rotatebuffers(SHIFTUP);
                    pxread(current);
                    }
                }
            pxredisplay();
            break;
        }
    pxrefresh();
    ,reor(TRUE);
    }


 * rotates buffer pointers for UP and DOWN  */
void rotatebuffers(int direction)
    {
    RECORD *p;

    if(direction == SHIFTDOWN)  /* copy RECORD pointers from 0 to 1*/
        {
        p = recs[maxrecs-1];
        memmove(&recs[1],&recs[0], ((maxrecs-1)*sizeof(RECORD *)));
        recs[0] = p;
        }
    else                        /* copy RECORD pointers from 1 to 0*/
        {
        p = recs[0];
        memmove(&recs[0],&recs[1], ((maxrecs-1)*sizeof(RECORD *)));
        recs[maxrecs-1] = p;
        }
    }

/* blanks a record buffer   */
void pxblank(RECORD *r)
    {
    memset(r->buf,' ',recsize);
    r->recno = 0L;
    }

/* reads the current record and number  */
void pxread(int which)
    {
    int retcode;

    if((retcode = PXRecGet(tblhdl,rechdl)) == 0)
        retcode = PXRecNum(tblhdl,&(recs[which]->recno));
    if(retcode)
        ScrErrMsg("Read",retcode);
    pxbuildrecdisplay(rechdl,numfields,fields,recs[which]->buf);
    }

/* reads maxrecs records from current position,
   then returns to that position
*/
void pxreread(void)
    {
    int             count, retcode;
    RECORDNUMBER    recnum;

    if(numrecs < 1L)
        return;

    for(count = 0; count < maxrecs; )
        {
        pxread(count);
        count++;
        if(PXRecNext(tblhdl))
            break;
        }
    for( ; count < maxrecs; count++)
        pxblank(recs[count]);
    current = 0;
    PXRecGoto(tblhdl,recs[0]->recno);
    }


/* writes the current record set to the screen buffer   */
void pxredisplay(void)
    {
    int count,i;
    char *ptr;

    atsayb(0,1,dispoffset,hdrbuf);

    for(count = 0; count < maxrecs; count++)
        {
$if defined(SLOWER)
        atsayb(count+1,1,dispoffset,"%s",recs[count]->buf);
$else
        scrptr = &screen[((count+1)*160) + 2];
        ptr = &recs[count]->buf[dispoffset];
        for( i = 0; i < bufblanks-2; i++, scrptr += 2)
            *scrptr = ptr[i];
$endif
        }
    }

/* updates the display from the screen buffer   */
void pxrefresh(void)
    {
$if defined(DEBUG)
    atsayb(24,2,0,"Rec #: %10ld/%-10ld, current=%22d, maxrecs=%02d, "
        "dispoffset=%03d",
        ((numrecs > 0L) ? recs[current]->recno : 0L),
        numrecs,current,maxrecs,dispoffset);
$else
    atsayb(24,2,0,"Rec #: %10ld/%-10ld",
        ((numrecs > 0L) ? recs[current]->recno : 0L),numrecs);
$endif
    ScrRefresh();
    }

/* reads structure of table */
int pxreadstructure(TABLEHANDLE tblhdl,
int numfields,FIELD **fields)
{
int i,retcode;
FIELD *f;
char fld[MAXFLDNAMESIZE], fldtype[MAXFLDTYPESIZE];

if((f = malloc(sizeof(FIELD)*numfields)) == NULL)
    {
    *fields = NULL;
    return PXERR_OUTOFMEM;
    }
                                /* get structure    */
for( i = 0, recsize = 0; i < numfields; i++)
    {
    memset(f[i].fldname,' ',MAXFLDNAMESIZE);
    f[i].fldname[MAXFLDNAMESIZE-1] = NULL;
    if((retcode =
        PXFldName(tblhdl,i+1,MAXFLDNAMESIZE,fld)) != 0)
        return retcode;
    strncpy(f[i].fldname,fld,strlen(fld));
    if((retcode =
        PXFldType(tblhdl,i+1,MAXFLDTYPESIZE,fldtype)) != 0)
        return retcode;
    f[i].fldtype = fldtype[0];
    switch(f[i].fldtype)
        {
        case 'N':
            f[i].flddispsize = MAXSHORTSIZE;
            break;
        case '$':
            f[i].flddispsize = MAXDOLLARSIZE;
            break;
        case 'D':
            f[i].flddispsize = MAXDATESIZE;
            break;
        case 'S':
            f[i].flddispsize = MAXSHORTSIZE;
            break;
        case 'A':
            f[i].flddispsize = atoi(&fldtype[1]);
```

PV.C 4 of 4

```
                break;
            }
        f[i].flddispoffset = recsize;
        recsize += f[i].flddispsize+1;
        }
    recsize++;
    *fields = f;
    return 0;
    }

/* builds the record header */
void buildheaderdisplay(int numfields, FIELD *fields)
    {
    int i,used = 0;
    char fieldname[MAXFLDNAMESIZE+1];

                                /* initialize       */
    if((hdrbuf = malloc(recsize+1)) == NULL)
        return;
    memset(hdrbuf,' ',recsize);
                                /* for every field..*/
    for(i = 0; i < numfields; i++)
        {
        strncpy(&hdrbuf[used],fields[i].fldname,
            min(strlen(fields[i].fldname),fields[i].flddispsize));
        used += fields[i].flddispsize+1;
        }
    hdrbuf[used] = NULL;
    }

/* builds the record for display in 80 characters */
void pxbuildrecdisplay(RECORDHANDLE rechdl,
        int numfields, FIELD *fields, char *recbuf)
    {
    int i,used = 0,retcode,mo,day,year,blank;
    long l;
    short u;
    double d;
    char temp[MAXDOLLARSIZE+1];

                                /* get each field   */
    for( i = 0; i < numfields; i++)
        {
        PXFldBlank(rechdl,i+1,&blank);
        if(blank)
            {
            d = 0L;
            l = 0L;
            retcode = u = mo = day = year = 0;
            fldbuf[0] = '\0';
            }
        switch(fields[i].fldtype)
        {
        case 'A':
            if(!blank)
                retcode =
                    PXGetAlpha(rechdl,i+1,sizeof(fldbuf),fldbuf);
            sprintf(&recbuf[used],"%-*s",
                fields[i].flddispsize,fldbuf);
            break;
        case 'S':
            if(!blank)
                retcode = PXGetDoub(rechdl,i+1,&d);
            sprintf(temp,"%7.2f",d);
            sprintf(&recbuf[used],"%*s",fields[i].flddispsize,
                temp);
            break;
        case 'N':
            if(!blank)
                retcode = PXGetLong(rechdl,i+1,&l);
            sprintf(&recbuf[used],"%*ld",
                fields[i].flddispsize,l);
            break;
        case 'S':
            if(!blank)
                retcode = PXGetShort(rechdl,i+1,&u);
            sprintf(&recbuf[used],"%*u",
                fields[i].flddispsize,u);
            break;
        case 'D':
            if(!blank)
                if((retcode = PXGetDate(rechdl,i+1,&l)) == 0)
                    retcode = PXDateDecode(l,&mo,&day,&year);
            sprintf(&recbuf[used],"%2d/%2d/%2d",mo,day,year);
            break;
        }
    if(retcode)
        ScrErrMsg("Building Record",retcode);
    used += fields[i].flddispsize;
    strcpy(&recbuf[used]," ");
    used++;
        }
    }


/* updates the current record   */
void pxupdate(void)
    {
    int i, retcode;
    char temp[MAXFIELDLEN+1];
    long l,longdate;
    unsigned u,mo,day,year;
    double d;

    for( i = 0; i < numfields; i++)
        {
        strncpy(temp,&recs[current]->buf[fields[i].flddispoffset],
            fields[i].flddispsize);
        temp[fields[i].flddispsize] = '\0';

        switch(fields[i].fldtype)
            {
            case 'A':
                retcode = PXPutAlpha(rechdl,i+1,temp);
                break;
            case '$':
                d = atof(temp);
                retcode = PXPutDoub(rechdl,i+1,d);
                break;
            case 'N':
                l = atol(temp);
                retcode = PXPutLong(rechdl,i+1,l);
                break;
            case 'S':
                u = atoi(temp);
                retcode = PXPutShort(rechdl,i+1,u);
                break;
            case 'D':
                temp[2] = temp[5] = '\0';
                mo = atoi(temp);
                day = atoi(&temp[3]);
                year = atoi(&temp[6]);
                PXDateEncode(mo,day,year,&longdate);
                retcode = PXPutDate(rechdl,i+1,longdate);
                break;
            }
            if(retcode)
                ScrErrMsg("Update",retcode);
        }
    PXRecUpdate(tblhdl,rechdl);
    }


/* sets the cursor to the end of the current field
   and optionally blanks the old location
 */
void cursor(int blankmarker)
    {
    int i;

    if(blankmarker && lastrow && lastcol)
        atsay(lastrow,lastcol," ");

    atsay(lastrow = current+1,
        lastcol =   ((1 + fields[currfield].flddispoffset +
                    (i = fields[currfield].flddispsize) -
                    dispoffset)),
        CURSORMARKER);
    for(curscol = 0,
        curptr = &recs[current]->buf[lastcol+dispoffset];
        i >= 0 && (*(curptr-1) == ' '); i--, curptr--, curscol++);
    curpos();
    }


static RECORDNUMBER numstack[MAXRECS];
static int stacknum = 0;

/* pushes a record number on the stack */
void pushrec(void)
    {
    PXRecNum(tblhdl,&numstack[stacknum++]);
    }

/* retrieves a record number from the stack */
void poprec(void)
    {
    PXRecGoto(tblhdl,numstack[--stacknum]);
    }
```

PV2.C 1 of 2

```
/* pv2.c RMB 1/22/90
 *
 */

#include<stdio.h>
#include<conio.h>
#include<alloc.h>
#include<dos.h>
#include<stdlib.h>
#include<string.h>
#include"pxengine.h"
#include"paraview.h"

static char workbuffer[MAXRECSIZE+1];
int errset = FALSE;

/* printf with row/column positioning */

void cdecl atsayb(unsigned row, unsigned col, unsigned offset,
        char *fmt, ...)
    {
    extern int bufblanks;
    va_list argptr;

    va_start(argptr,fmt);
    vsprintf(workbuffer,fmt,argptr);
    va_end(arg_ptr);

    gotoxyb(row,col);    /* position cursor  */
    workbuffer[offset+bufblanks-col] = NULL;
    putsb(&workbuffer[offset]);
    }

void putsb(char *buf)
    {
```

Figure 3: PV2.C is the support code for the screen and keyboard.

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- ☐ **INDIVIDUAL CREDIT** but rely on income or assets of another person as a basis for repaying the credit requested. Complete entire application.
- ☐ **INDIVIDUAL CREDIT.** Complete sections "a" and "b" only

Please complete all appropriate sections, providing at least two year's residence and employment history. This will enable your application to be processed as quickly as possible. If you are self-employed, please be sure to complete section "D" on back.

Applicants must be 18 years of age or older.

a. Your Personal Information — Requested Line of Credit $

Your Name: First Initial Last — Date of Birth: Mo Day Yr — Social Security Number:

Present Address Street Apt. # City State Zip — Home Phone ( ) —

Date of Residence: Month Year — Monthly Payment: $ — Buy ☐ Rent ☐ Other ☐

Previous Address. — Dates of Residence: From To

Your Employer: (If self-employed, see rear panel) — Date of Employment: Mo Yr — Position. — Monthly Income. Gross $ Net $

Employer's Address. Street City State — Business Phone ( ) —

Previous Employer: — Address. — Dates of Employment: From To

Income from alimony, child support or separate maintenance payments need not be disclosed if you do not wish to have it considered as a basis for repaying this obligation.

Other Income.

I have received since: (Date) — Monthly Income. Gross $ Net $

Name and Address of Nearest Relative Not Living With You: — Relationship

b. Credit Information — Include joint applicant's information, if joint account requested

Bank Account: Bank Name Address — Checking Savings

Bank Account: — Checking Savings

		Payment	Balance
Bank Loan Reference			
Bank Card Reference	VISA MasterCard		
Other Credit Card Reference			
Other Credit References:	Account No Expires		

Driver's License No State Expires

c. Joint Applicant's Personal Information — *If you are a married Wisconsin applicant, you must provide your spouse's information below, even though your spouse may not be signing this contract

Joint Applicant's Name: First Initial Last — Date of Birth Mo Day Yr — Social Security Number:

Address Street Apt. # City State Zip — Date of Residence: Mo Yr — Home Phone ( ) —

Employer: — Date of Employment: Mo Yr — Position: — Monthly Income: Gross $ Net $

Employer's Address Street City State — Business Phone: ( ) —

d. Self-Employed Information — Complete this section only if you are self-employed

Business Name — Proprietorship Corporation Partnership

Business Address — Business Telephone ( ) —

Description of Business — Your Position — In Business Since

Your annual income from business — Business annual income (gross) (net)

You must provide at least one of the following

1. Business Bank Name — Telephone ( ) — Personal Banker's Name
2. Accountant's Name — Telephone ( ) —
3. **Financial statement on business attached**

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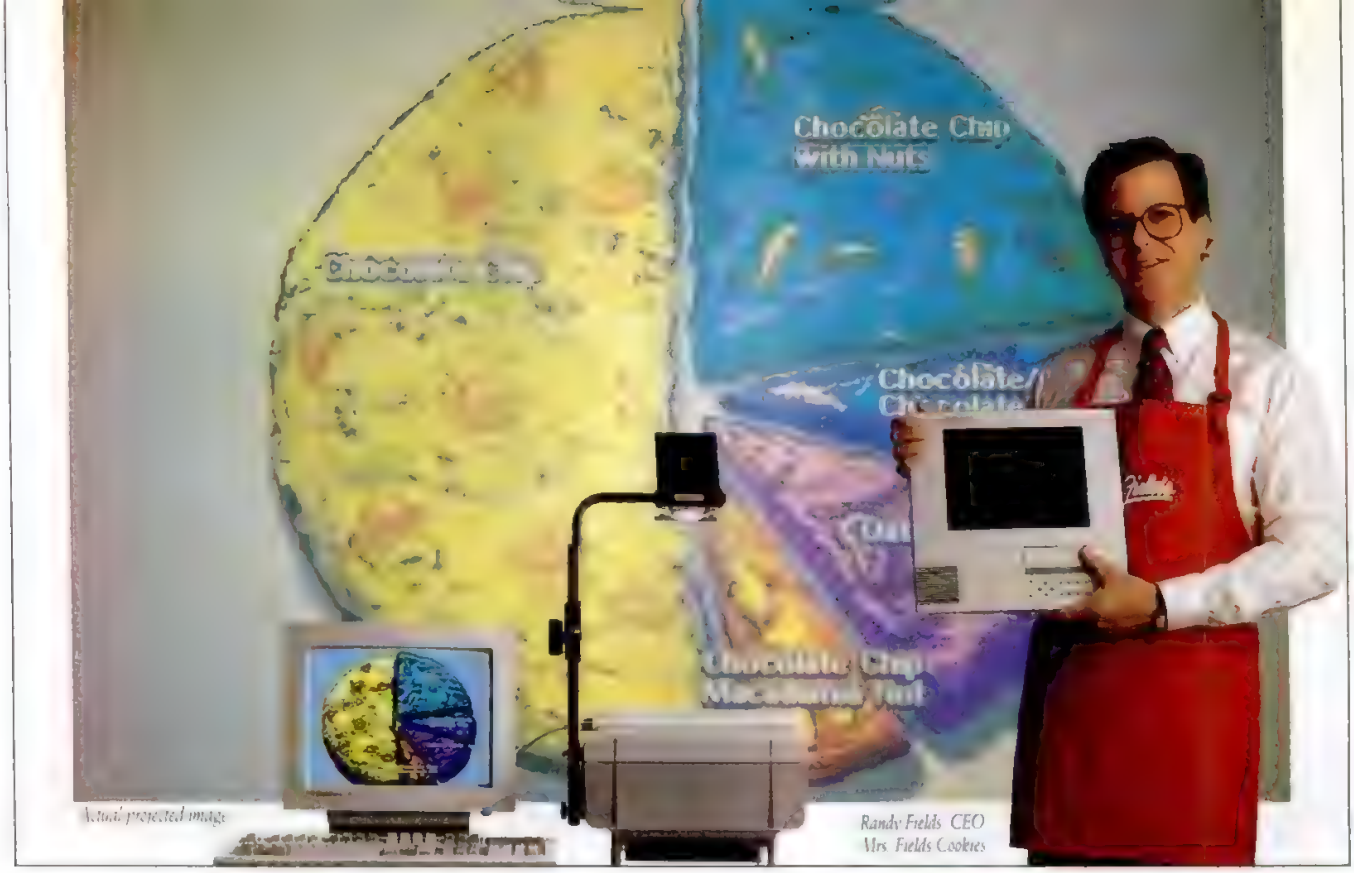
PV2.C 2 of 2

```
    for( ; *buf; buf++, scrptr += 2)
        *scrptr = *buf;
    }

/* printf with row/column positioning */
void cdecl atsay(unsigned row, unsigned col, char *str)
    {
    gotoxy(col+1,row+1);    /* position cursor  */
    puts(str);   /* print message    */
    }

    /* creates a bordered, colored window
       at the passed coordinates;
       resulting active window is the area INSIDE the borders
     */
void Scrcreate(int top, int left, int bottom, int right,
    int foreground, int background)
    {
    int i,width = right-left,height;

    textcolor(foreground);                  /* set foreground color */
    textbackground(background);             /* set background color */
    clrscr();                               /* clear the window     */
    Scrcolor(foreground,background);
    Scrclr();

    gotoxyb(top,left);
    *scrptr = 194;                          /* write upper left     */

    gotoxyb(top,width);
    *scrptr = 194;                          /* write upper right    */

    for( i = top+1, height = bottom-top; i < height; i++)
        {
        gotoxyb(i,0);
        *scrptr = 179;                      /* left border          */
        gotoxyb(i,width);
        *scrptr = 179;                      /* right border         */
        }
    gotoxyb(bottom,left);
    *scrptr = 212;
    scrptr += 2;
    *scrptr = 181;                          /* bottom left corner   */
    gotoxyb(bottom,width);
    *scrptr = 198;                          /* bottom right corner  */
    scrptr -= 2;
    *scrptr = 198;
    }

/* colors screen    */
void Scrcolor(unsigned foreground, unsigned background)
    {
    unsigned colorval = foreground+(background << 4), count;

    for( count = 1; count < sizeof(screen); count += 2)
        screen[count] = colorval;

        }

        /* clears screen    */
        void Scrclr(void)
        {
    unsigned count = 0;

    for( ; count < sizeof(screen); count += 2)
        screen[count] = ' ';
    Scrrefresh();
    }


/* saves/restores screen - assumes 80x25 color mode   */
void Screen(int save)
    {
    static int row,col;
    static unsigned screen_buffer[25*80];  /* screen storage buffer*/

    if(save)
        {
        textmode(C80);                      /* 80 column, color mode*/
        row = wherey();                     /* save row position    */
        col = wherex();                     /* save column position */
        gettext(1,1,80,25,screen_buffer);   /* save screen          */
        }
    else
        {
        normvideo();                        /* reset to normal video*/
        puttext(1,1,80,25,screen_buffer);   /* restore screen       */
        gotoxy(col,row);                    /* reposition cursor    */
        }
    }

/* returns ascii or scan code value of a key */
int getkey(void)
    {
    int key = getch();

    if(!key)
        {
        key = getch();
        return SCANCODE(key);
        }
    return key;
    }

/* writes error messages to the screen buffer and displays it */
int ScrErrMsg(char *str,int err)
    {
    if(errset)
        {
        sprintf(workbuffer,"%38s","");
        errset = FALSE;
        }
    else
        {
        sprintf(workbuffer,"%s error: %s",str,PXErrMsg(err));
        errset = TRUE;
        }
    gotoxyb(24,40);
    putsb(workbuffer);
    Scrrefresh();
    return 0;
    }
```

PARAVIEW.H COMPLETE LISTING

```
/* paraview.h RHS 1/22/90
 *
 */

#define MAXFLDNAMESIZE  26
#define [illegible]     5
#define MAXLINELEN      78
#define [illegible]     5
#define MAXDOLLARSIZE   10
#define [illegible]     8
#define [illegible]     15
#define MAXFIELDLEN     255
#define MAXRECSIZE      4000
#define MAXRECS         23
#define MAXPSWLEN       15
#define CURSORMARKER    "\021"
#define MAXFIELDS 255

#define SCANCODE(key)   (key | 0x100)
#define HOME            SCANCODE(71)
#define END             SCANCODE(79)
#define PGUP            SCANCODE(73)
#define PGDN            SCANCODE(81)
#define UP              SCANCODE(72)
#define DOWN            SCANCODE(80)
#define LEFT            SCANCODE(75)
#define RIGHT           SCANCODE(77)
#define TAB             9
#define SHIFTTAB        SCANCODE(15)
#define DEL             SCANCODE(83)
#define ESC             27
#define BACKSPACE       8
#define INSERT          SCANCODE(82)
#define ENTER           13

#define SAVE    1
#define RESTORE 0
#define SHIFTDOWN       0
#define SHIFTUP         1

    /* FIELD date type      */
typedef struct _field
    {
    char        fldname[MAXFLDNAMESIZE];
    char        fldtype;
    int         flddispsize;
    int         flddispoffset;
    } FIELD;

typedef struct _record
    {
    char        *buf;
    long        recno;
    } RECORD;

extern char *scrptr;
extern char screen[80*25*2];

    /* macro'd functions */
#define gotoxyb(row,col)    (scrptr = &screen[(row*160)+(col*2)])
#define Scrrefresh()        puttext(1,1,80,25,screen)
#define curpos()            gotoxy(lastcol+2-curscol,lastrow+1)
#define ErrMsg(str,err)     printf("%s error: %s",str,PXErrMsg(err))

    /* function prototypes  */
void Scrcreate(int top, int left, int bottom, int right,
        int foreground, int background);
void Screen(int save);
void atsay(unsigned row, unsigned col, char *fmt);
void atsayb(unsigned row, unsigned col, unsigned offset, char *fmt,
        ...);
void putsb(char *buf);
void Scrclr(void);
void Scrcolor(unsigned foreground, unsigned background);
int  getkey(void);
int  main(int argc, char **argv);
int  pxreadstructure(TABLEHANDLE tblhdl,
        int numfields, FIELD **fields);
void buildheaderdisplay(int numfields, FIELD *fields);
void pxbuildrecdisplay(RECORDHANDLE rechdl,
        int numfields, FIELD *fields, char *recbuf);
void pxreread(void);
void displayer(int key);
void editor(int key);
void edit(int key);
void pushrec(void);
void poprec(void);
void rotatebuffers(int direction);
void pxread(int which);
void pxredisplay(void);
void cursor(int blankmarker);
void pxupdate(void);
void pxblank(RECORD *r);
void pxrefresh(void);
int  ScrErrMsg(char *str,int err);
```

Figure 4: The header file for PARAVIEW, a file viewing utility.



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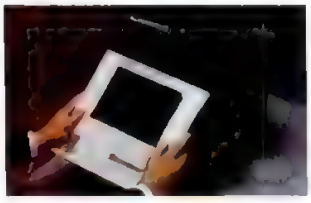

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CIRCLE 748 ON READER SERVICE CARD

into one of the row buffers. The latter function in turn uses several Engine API functions: PXFldBlank to detect empty fields, and PXGetAlpha, PXGetDoub, PXGetLong, PXGetShort and PXGetDate to retrieve alphanumeric, dollar, long and short integer, and date fields from the current table row.

Whenever PARAVIEW needs to read up to a screenful of rows from the table, it calls the function pxreread. Using the current row position in the table as a starting point, pxreread calls pxread in a loop to read each row. It uses PXRecNext to skip from one record to the next, and if pxreread runs out of rows to read before it runs out of buffers, it blanks the remaining buffers with the function pxblank. Finally, pxreread uses PXRecGoto to reset the table back to the record associated with the first record buffer.

Whenever PARAVIEW needs to display the rows stored in the record buffers, it calls the function pxredisplay. As originally written, pxredisplay called atsayb in a loop to prepare each row buffer for display. However, it was rewritten to reduce the time spent in atsayb, and provide a high-performance interface to the screen display buffer. The rewritten portion uses a pointer into the screen display buffer to stuff the contents of each row directly into the buffer.

PARAVIEW can update the video display from the screen-display buffer at any time by calling pxrefresh. This function displays the current record number and calls Scrrefresh to write the screen-display buffer directly to the video display. Once PARAVIEW displays the initial screenful of rows from the table, it's ready to process keystrokes from the operator.

KEYBOARD INPUT AND TERMINATION

PARAVIEW allows only two types of keyboard input: display command keys and editing keys. The former are passed to the displayer function, which allows you to navigate the table. There's nothing particularly unusual about this function; as it evaluates each key, it takes the appropriate steps to navigate the table. For instance, if you press Home, the displayer will jump to the first record in the table and redisplay the rows. If you press PgDn, the function jumps to the last record displayed on the screen, skips to the next record after that,

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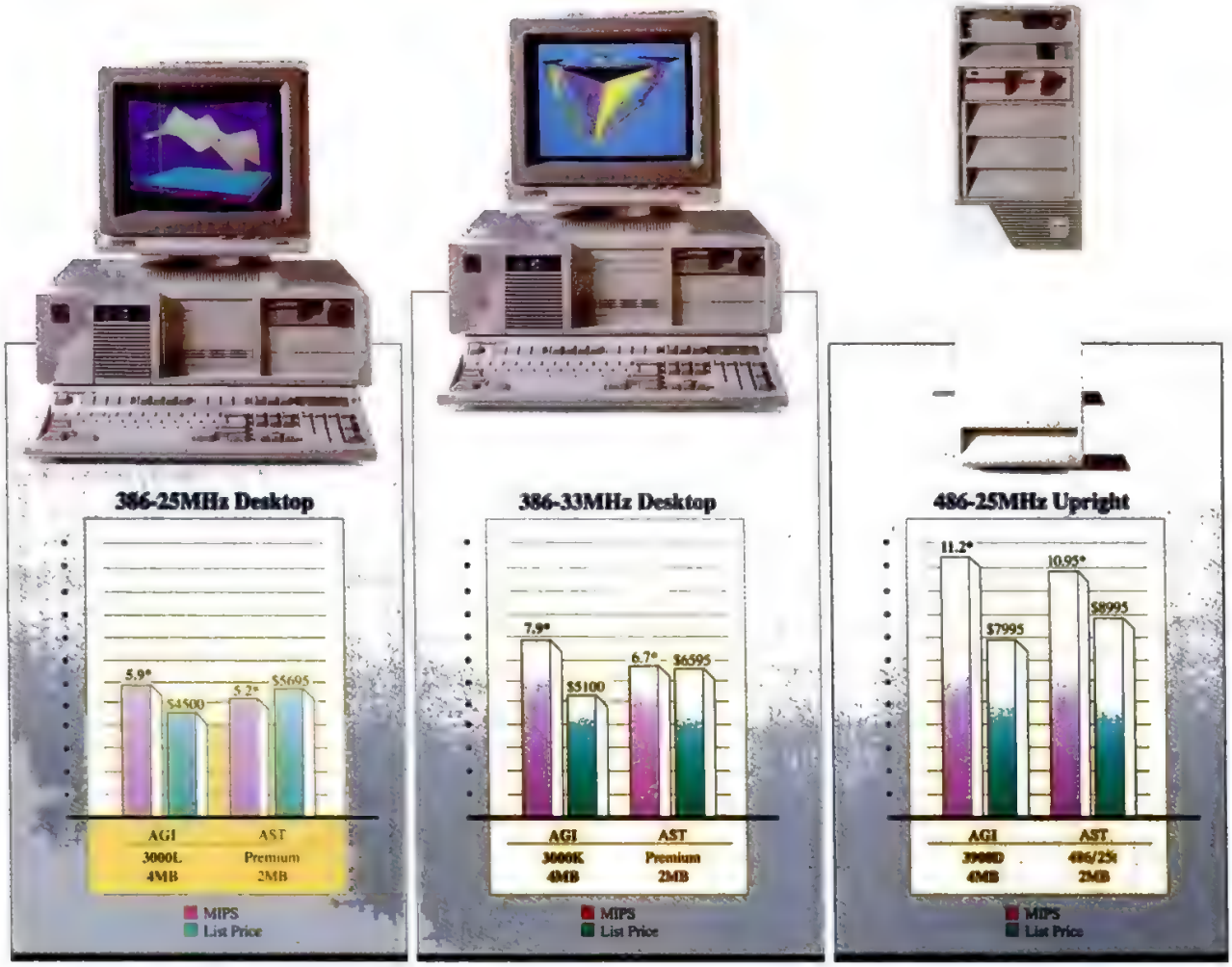

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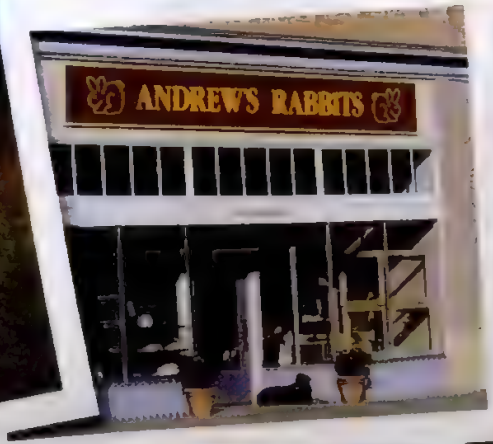

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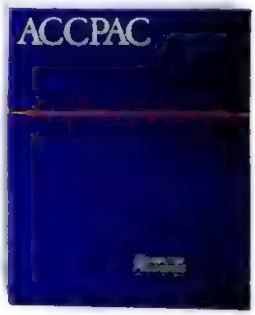

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and rereads and redisplays the records from there. The function does perform some simple checking to avoid reading the table if the number of rows in the table is less than those that can be displayed on-screen. And, it optimizes Up and Down Arrow key presses from you to use the rows on-screen when appropriate.

The editor function allows you to tab left and right from field to field as described earlier. To do this, it simply determines whether the field being shifted to is partly off-screen. If so, this function resets the global display offset variable and redisplays the rows.

The editor function passes other editing keys on to the edit function. This routine lets you delete the current row (using PXRecDelete), or edit the current field.

The editing interface uses a global pointer that is reset whenever the cursor is moved or the rows are redisplayed. This pointer always points to a position in the current row buffer that corresponds to the cursor's position on-screen. Thus, when you press Backspace, the pointer is decremented, and a space is inserted into the buffer (the cursor is also shifted to the left). Conversely, if you insert a character, then that character is placed in the buffer, the pointer is incremented, and the cursor is shifted right. In either of these situations, a global flag is set indicating that the current row has been modified. Any move to another row or attempt to terminate the program will result in a call to the pxupdate function (which in turn calls PXRecUpdate). Pxupdate updates the current table row. Consequently, you can make changes to every field in the current row without those changes being written to the table until editing of that row is complete.

If you press Esc, PARAVIEW will break out of the key-processing loop. After checking for a final row update, the program closes the record-transfer buffer and the table (using PXRecBufClose and PXTblClose). Then it shuts down the *Paradox Engine* with PXExit and makes a final call to Screen to restore the original display.

EXPERIMENT WITH PARAVIEW

Despite the fact that good engineers adhere to the maxim, "The design isn't complete until all the extraneous features have been tossed out," there are a few features you might consider adding to PARAVIEW. Currently, PARAVIEW lets you use only the default index. But you could edit the source code so that you can switch between indexed views of a table. Adding support for 43- and 50-line text mode or graphics mode with mouse support would make it even nicer to use. Finally, you could change the program so that it allows field validation checking (as does *Paradox*) and takes advantage of the *Paradox Engine*'s network concurrency.

To add capabilities to PARAVIEW, you'll need Turbo C 2.0 and *Paradox Engine* 1.0. Then simply edit the source code and recompile the program using

```
tcc -ml -ePARAVIEW.EXE pv pv2
 pxengtcl.lib
```

Although PARAVIEW uses some Turbo C specific functions, it would be easy enough to port it to some other C compiler supported by the *Paradox Engine*, such as Microsoft C.

Though the use of C may seem a difficult hurdle to leap over, anyone with a year or so of development experience with *dBASE*, *Clipper*, *FoxPro*, and so on, can make the transition. It should be obvious from the text that the *Paradox Engine* calls are not much different from the calls you make everyday with any of the database languages. In fact, though PARAVIEW was written in C, any database programmer can make sense of the discussion presented here. There will be a substantial payback for anyone willing to test his ability to challenge the hurdle.

PARAVIEW is a handy program for viewing and modifying *Paradox* tables, and you don't even need *Paradox* to use it. So I hope you add it to your *PC Magazine* utilities, but more than this I hope it will serve as a catalyst for your ideas and what you can do with the *Paradox Engine*.

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Research for this article was provided by Richard Hale Shaw, a contributing editor of PC Magazine.

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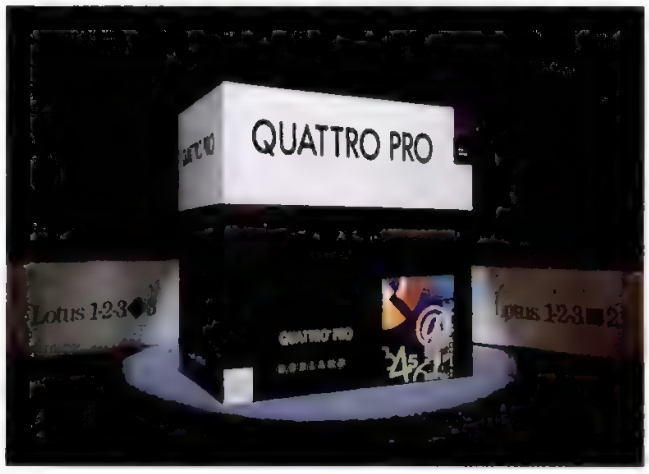

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CIRCLE 377 ON READER SERVICE CARD

by
Craig Stinson

Spreadsheets

TIME WELL SPENT IN LOTUS 1-2-3

I developed a macro (Figure 1) that lets me track my time developing and using spreadsheets. It accounts not only for each time period I have a file open, but for the total time I have ever been in each file.

If I'm away from the keyboard for a while, I save the file before I go and save it again when I return. If no entries have been made between file savings, the timer does not advance. This prevents me from counting time I'm not actually working on the file.

Steve Williams
Bellingham, Washington

People who bill for the time they spend in *1-2-3* will find this is a very useful macro. When the file containing the macro is loaded, the Auto-Execute macro (\0) initiates the time recording macro from the TSTART instruction. The macro immediately puts the current time into cells B9 and B10 (ENDTIME and STARTTIME, respectively). Then the instruction in B5 uses /Range Values to freeze the starting time. Cell B11 (NETTIME) records the difference between ENDTIME and STARTTIME (initially zero). From this point on, as the user works in the file, any time a cell is changed, @NOW—and thus ENDTIME and NETTIME—is updated. But because the @NOW formula in B9 is not recalculated while you're just staring at the screen or moving around the worksheet with the cursor keys, the macro doesn't automatically log idle time. Each time you use Alt-T to save the file, the current value of NETTIME is added to the TODATE cell, and the STARTTIME cell is reset to the current time. So when you come back to the machine after a period of inactivity, all you have to do is press Alt-T; that way, your downtime won't be counted.

To create this macro, enter the labels shown in A2..A15, B2..B7, and B15. In B9, enter the formula @NOW. Leave B10 and B13 blank (the macro will fill them in). In B11, enter the formula +ENDTIME-STARTTIME. Format B9 and B10 with /RFDT4 (the short international time format), and B11 and B13 with /RFDT3 (long international). Use /RNLR to assign the labels in column A to the corresponding cells in column B.

- **TIME WELL SPENT IN LOTUS 1-2-3:** Automatically track and record the time you spend working in a file.
- **THE CASE FOR FORMULAS:** Type Excel formulas in lowercase and reduce the chance of mistakes.
- **AN ECCENTRIC /RANGE JUSTIFY:** Use this Lotus 1-2-3 menu option with care: it could turn your worksheet into mush.
- **AN ALTERNATIVE TO @IF:** There are times when it pays to build formulas with a conditional statement.

THE CASE FOR FORMULAS

After you type in a formula and press Enter, *Excel* checks for syntax errors. If the syntax for the formula is correct, it converts it to uppercase. If *Excel* does not recognize the formula, it treats the entry as a text comment and leaves it in lowercase. So, with the exception of capitalized text in quotes, I always type my formulas in lowercase to ensure that I don't make any mistakes.

This precaution is a big help in writing macros. Some syntax mistakes in *Excel* macros—leaving out a period, for example—are easy to miss because of *Excel*'s graphic spacing. But if you enter everything in lowercase, you can spot trouble immediately, before you try to run the macro.

Daniel F. Licata
Rochester, New York

Microsoft Excel converts all legal syntax to uppercase, whether it's in a worksheet or a macro sheet. You see the capital letters in your macro cells because they're ordinarily formatted to display formula text instead of formula results. If you find periods and commas hard to read on macro sheets, you may also want to format your entire macro sheet in a larger and bolder font. Soft fonts are great for this; punctuation is pretty easy to read in 18-point Burlesque.

TIME-TRACKING MACRO — **COMPLETE LISTING**

```
     A              B              C              D
1
2  \t             {let TODATE,TODATE+NETTIME}
3  TSTART         {recalc ENDTIME}
4                 {let STARTTIME,@now}~
5                 /rvSTARTTIME~STARTTIME~
6                 /fs~r
7                 {quit}
8
9  ENDTIME        08:44              @NOW
10 STARTTIME      08:44
11 NETTIME     00:00:00              +ENDTIME-STARTTIME
12
13 TODATE      00:10:50
14
15 \0          {TSTART}
```

Figure 1: This macro records the amount of time you spend working on a file.

AN ECCENTRIC /RANGE JUSTIFY

I find unpredictable and damaging results when I use the /Range Justify command in *Lotus 1-2-3*.

The option, which rearranges the dimensions of a column of text, is easy to invoke. At the prompt you simply enter the justify range. The width of the range determines the length of the individual parts, while the height of the range determines the number of rows the rearranged label will occupy.

Figures 2 and 3 illustrate the process. The worksheet in 2 contains a long label in cell A1, numeric values in cells A5..A9, and formulas in B5..B9; the formulas reference the cells to their immediate left. If you justify the label in A1, using a range of A1..C1, *1-2-3* delivers the worksheet that is shown in Figure 3. As you can see, *1-2-3* has divided the label

```
A1: 'Now is the time
 for all good men to
 come to the aid of
 their country.
```

in cell A1 into the following three parts:

```
A1: 'Now is the time
 for all
A2: 'good men to come
 to the
A3: 'aid of their
 country.
```

The specified range was only one row in height; this signals to *1-2-3* that the height of the column is open-ended, and thus the divided label will occupy as many rows as necessary to accommodate the new width.

But specifying a "floorless" range has its costs: the entries in cells A5..A9 do not remain in their original location. The value 123, which was originally in cell A5, is now in cell A7; the value 234, which was originally in cell A6, is now in cell A8; and so forth.

This shift itself may not be bothersome. But real problems do occur because the formulas in column B did not move with the entries that they referenced.

In the original worksheet, cells B5..B9 contain the formulas

```
B5: +A5
B6: +A6
B7: +A7
B8: +A8
B9: +A9
```

As you can see in Figure 3, the formulas in cells B5..B8 still reference cells A5..A8—even though the contents of those cells have moved into A7..A10. This alone ruins the worksheet, but even stranger, cell B9 no longer contains the formula +A9. Instead, it contains the formula +A3—a reference to the cell that contains the final portion of the justified label. Consequently, it returns the string "aid of their country."

Robert Collins
Atlanta, Georgia

You should save your file before using /Range Justify in *Lotus 1-2-3*, Release 2.*x* (2, 2.01, and 2.2), because the command is definitely buggy. Release 1A gets it right, and so does Release 3. In both Release 1A and Release 3, if *1-2-3* needs to move data down to make room for the reformatted text, it adjusts any formulas that reference the moved data—just as it would if you used /Move. However, in 2.*x*, the formulas are not adjusted, and the program spits out text in the wrong places.

There's at least one other problem with the /Range Justify option in Release 2.*x*, besides the one Mr. Collins describes. If you specify a multiline justify range that isn't roomy enough for the parse, *1-2-3* beeps and flashes its Error indicator. But when you press Esc to clear the error message, the program proceeds to reformat as much text as it can—instead of not doing anything and allowing you to try a different justify range.

For reference, *Quattro Pro* has some of the same problems as *1-2-3*, Release 2.*x*. Formulas that reference the moved data are not adjusted to reflect the move, but the text is handled correctly.

Microsoft Excel takes a different ap-

THE UNPREDICTABLE RESULTS OF JUSTIFICATION

```
     A        B        C        D        E
1    Now is the time for all
2    good men to come to the
3    aid of their country.
4
5                  0
6                  0
7       123      123
8       234      234
9       345 aid of their country.
10      456
11      567
12
```

Figure 3: This worksheet shows the result of justifying the label in Figure 2. The label has been perfectly divided, pushing the number labels down to accommodate the new height. However, in the process, the formulas in column B have not moved with the shifted cells.

SAMPLE DATA BEFORE JUSTIFICATION

```
      A        B        C        D        E        F        G        H
1   Now is the time for all good men to come to the aid of their country.
2
3
4
5       123      123
6       234      234
7       345      345
8       456      456
9       567      567
10
```

Figure 2: Cell A1 of this worksheet contains a long label that will be justified with a 3-column width and an open-ended height.

proach. If your selection is not large enough to accommodate the output of a Format Justify command, *Excel* puts up a dialog box to warn you. But if you tell it to go ahead, it simply overwrites any data that lies in its way.

AN ALTERNATIVE TO @IF

Lotus 1-2-3's @IF function returns one of two answers, depending on whether its first argument, a conditional test, is true or false. If the test is true, the answer will be the value of the second argument; if the test is false, the answer will be the value of its third argument.

While @IF does have its place, many people use it in situations where it's not really required. For example, suppose your bank charges $.40 per check when the balance in your account falls below $1,000. In order to determine the new balance after a check is drawn, you could use @IF in the formula

```
@IF(BALANCE-CHECK>=
 1000,BALANCE-CHECK,
 BALANCE-CHECK-.4)
```

However, you could just as easily use a Boolean expression to calculate the new balance; simply rewrite the previous formula as:

```
+BALANCE-CHECK-.4*
 (BALANCE-CHECK<1000)
```

The logic of the formula is fairly simple. If subtracting the amount of a check from the current balance produces a value less than 1,000, then the expression BALANCE-CHECK<1000 will be true. Since *1-2-3* assigns the value 1 to true conditions, it will subtract .4*1, or .4, from the adjusted balance. If subtracting the amount of a check from the current balance produces a value greater than or equal to 1,000, then BALANCE-CHECK<1000 will be false. *1-2-3* assigns the value 0 to false conditions. Consequently, it won't subtract anything from the balance beyond the amount of the check itself. When I can, I prefer to use a Boolean expression; it offers a more straightforward and less complex alternative to the @IF function.

Les Bueckert
Redcliff, Alberta
Canada

True, enough, there are many situations in which you can use a Boolean expression such as (BALANCE-CHECK<1000) in place of an @IF function. This substitution usually makes for a trimmer, less memory-consuming formula. If you're developing macros for others to use, conserving memory is always a good idea; it ensures that your application will run on the widest-possible range of machines.

Using a Boolean expression in place of an @IF function produces a trimmer and less-memory consuming—albeit more abstract—formula.

As an experiment, I tried using Mr. Bueckert's example in two different worksheets—one with 100 @IF formulas, the other with 100 Boolean formulas. The Boolean approach saved about 2K in *Excel* and *Quattro Pro* and about 1K in *1-2-3*, Release 2.2.

The drawback to using a Boolean expression in place of @IF is that it makes the formula a little more abstract and potentially difficult to read. Most of us humans are more at home with a construct like "If A, then B; else C" than with something like "A minus B minus X times Boolean-test."

So if you're just developing spreadsheets for your own use and you have enough memory to spare, you might prefer just to stick with the old familiar @IF formulation.

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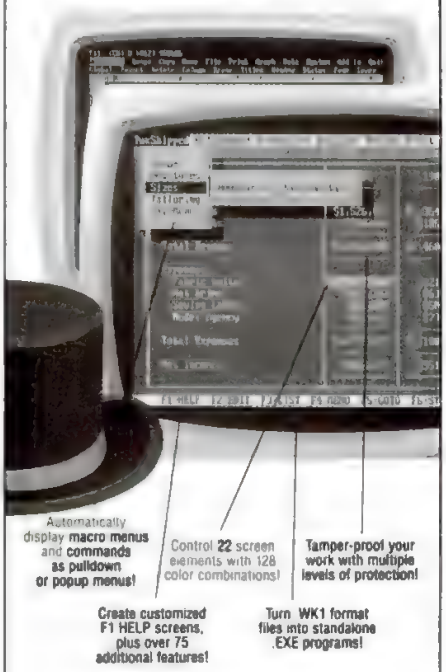

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CIRCLE 119 ON READER SERVICE CARD

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CIRCLE 742 ON READER SERVICE CARD

by
Craig L. Stark

The Working Word

Both of the *WordPerfect* reader submissions that constitute this issue's column offer the potential for outstanding productivity increases. These two items will be of particular help to users who are making the transition from keystroke and formatting macros to the advanced alternatives that are possible only through a feature essential in today's full-service word processors: the macro programming language. The techniques described here demonstrate macro programming itself and its use in a real-world application.

- BOOLEAN LOGIC: An undocumented feature lets you test complex conditions in WordPerfect 5.1.
- MASSIVE MERGES: An advanced WordPerfect 5.0 macro that reads source-file text.

BOOLEAN LOGIC

Although the fact is not documented, full Boolean logic can be used in *WordPerfect* 5.1 macros. This makes it possible to condense and simplify conditional testing, which must take more than one factor into account. Boolean logic employs a sequence of comparisons to arrive at a decision, as in:

```
if a=b AND c=d, then...
if a=b OR  c=d, then...
```

The first test passes only when both comparisons are valid. The second passes if either comparison is valid.

You can implement this kind of procedure within a single macro expression by using the logical AND (&) and the logical OR (|) operators. The virgule symbol (|) for the latter is the character that appears above the backslash on most computer keyboards.

Consider, for example, the relative economy in the following tests to determine whether a variable has a value between 10 and 15. In Version 5.0 you might write,

```
{IF}{VAR 1}>9~
     {IF}{VAR 1}<16~
     {;}Action executed only if
      both tests pass~
{END IF}{END IF}
```

In *WordPerfect* 5.1 this becomes the more efficient:

```
{IF}{VAR 1}>9&{VAR 1}<16~
     {;}Action, as before
{END IF}
```

A macro that determines whether the letter at the cursor is upper- or lowercase can be made by using the new {SYSTEM}right~ command to read the character and feed the result into the new {KTON} (key to number) command. {KTON} converts the character to its *WordPerfect* Key Value. The test is based on the fact that lowercase letters are 97–122 in *WordPerfect* Character Map Zero (and in the ASCII table); uppercase letters are 65–90. The actions in this example are generic and can be anything the user wants to implement:

```
{ASSIGN}1~{KTON}{SYSTEM}right~~~
    {IF}{VAR 1}>96&{VAR 1}<123~
          {;} lower case action~
    {ELSE}{IF}{VAR 1}>64&{VAR
     1}<91~
          {;} upper case action~
    {END IF}{END IF}
```

If the character at the cursor is not a letter, both tests fail, and the macro does nothing. Note the triple tilde in the first line, which delimits, respectively, the {SYSTEM} command, the {KTON} command, and the entire {ASSIGN} statement.

Similarly, a macro can find out whether the character at the cursor is an A, and if it is upper- or lowercase. The logical OR allows for either possibility,

```
{ASSIGN}1~{SYSTEM}right~~
{IF}"{VAR 1}"="A"|"{VAR 1}"="a"~
   {;} If "A" confirmed, action~
{END IF}
   {;} Macro falls through to
         here if non-A~
```

Note that, unlike the previous example, testing for a nonnumeric value requires that both elements in each comparison be enclosed in quotes.

The above examples can serve as models for constructing longer and more sophisticated Boolean tests, such as:

```
if a=b AND c=d OR x=y
```

Boolean expressions can also be used with the new {WHILE} command in Version 5.1. Because the actions controlled by these tests can be just about anything *WordPerfect* can perform, the potential is limited, in effect, only by the user's imagination. This approach cannot be used with Version 5.0 macros. The enabling of multiple expressions is but one of the many underpublicized virtues of *WordPerfect* 5.1.

Jordan V. Hodgson
Torrance, California

A couple of points should be added to those made by Mr. Hodgson. *WordPerfect* doesn't know the difference between Boolean and numeric expressions. FALSE has the value 0, and TRUE has the value −1. In a conditional test any nonzero value will register as true. Thus, it's a common practice for *WordPerfect* macros to make use of expressions such as {STATE}&1024. If a yes/no question is pending, the expression will evaluate to 1024; if not, it will be 0.

A problem arises when you try to combine two such expressions with & or |. Since these operators have equal precedence, *WordPerfect* simply evaluates the whole expression from left to right, and the result is not what you might expect. To

check whether Block is on or Reveal Codes mode is active, for example, you might be tempted to use the expression

```
{STATE}&128|{STATE}&512
```

This expression is true *only* when Reveal Codes is active, regardless of whether Block is on.

To circumvent the problem, you can either make use of parentheses to specify the order of evaluation or you can use explicit comparisons that return TRUE or FALSE, e.g. {STATE}&128=128.

MASSIVE MERGES

I maintain a large (1,000-plus record) *WordPerfect* 5.0 secondary merge file for my company. To conserve space, I abbreviate the 57 different addresses of the company's mailing facilities into a two- or three-character code, each beginning with a unique "|" character (|a, |b, |c1, |c2, etc.). Using this large file, I create a multipage letter (a *WordPerfect* primary file), merge the two, and create a *very* large file.

Before I could mail the letters, though, it was always necessary to go back and convert all of the address codes from their abbreviated form into their United States postal address equivalents. So I wrote a macro that would search for all occurrences of the first address code (|a), substitute the appropriate U.S. postal address, return to the top of the document, and repeat the process for each of the 57 different addresses of my company. This macro took a long time to execute, since *WordPerfect* had to go through the entire document 57 times.

It's more efficient to have *WordPerfect* go through the document once, changing the address codes as it encounters them. But, the macro editor has no facility to instruct the macro to read the *WordPerfect* text itself. The macro editor's ASSIGN command only assigns a variable's value that is defined within the macro. For example,

```
{Assign}1~254~
```

assigns the value 254 to variable 1.

If you are not working in the macro editor, you can assign variables by blocking the desired text, pressing MACRO COMMANDS (Ctrl-PgUp), and typing the variable number (0–9). However, if you are in the macro editor, pressing the Ctrl-PgUp key combination only brings up the macro command list. You can't assign a variable within in the macro editor.

By creating a dummy macro that blocks some text and assigns it to variable 1, *WordPerfect* put the command,

```
{Macro Commands}31
```

into the macro.

Further experimentation disclosed that if you are editing a macro, pressing MACRO DEFINE (Ctrl-F10) and then pressing MACRO COMMANDS (Ctrl-PgUp) will give you the desired {Macro Commands} code. You will still need to complete the macro action by adding a 3 (for the assign option), and the variable number (0–9). You can then return to the edit state by pressing MACRO DEFINE again.

A more efficient macro for multiple address substitutions is shown in Figure 1. Remember, in order to get variables while you're in the macro editor, you press Ctrl-V and then Alt-#, where # is your selected variable number (0–9).

Now my macro runs much faster (56 times faster to be precise), and I have time to get on with my work.

Bennett Dear
Costa Mesa, California

ADDRESS CODE CONVERSION MACRO TEMPLATE

```
{Home}{Home}{Up}          {;}Go to top of file~
{ON NOT FOUND}            {;}Exit condition when search fails~
    {GO}Nomore~~

{LABEL}Loop~
{Search}|{Search}         {;}Search for unique character~
{Block}{End}              {;}Block the rest of the line~
{Macro Commands}31        {;}Assign to variable 1~

{Home}{Home}{Left}        {;}Delete the address code line~
{Del to EOL}

{CASE CALL}{VAR 1}~       {;}Based on text just read,~
    a~Addr1~              {;}translate address~
    b~Addr2~
    c1~Addr3~
    _ ...                 {;}Additional addresses as needed~
                          {;}Remember this final tilde!~
{GO}Loop~                 {;}Get next address~

{LABEL}Addr1~
   <address 1>            {;}Address for code |a~
{RETURN}
{LABEL}Addr2~
   <address 2>            {;}Address for code |b~
{RETURN}
{LABEL}Addr3~
   <address 3>            {;}Address for code |c1~
{RETURN}


{LABEL}Nomore~
{BELL}                    {;}Beep to tell me it's done~
{QUIT}
```

Figure 1: This is a template for a *WordPerfect* 5.0 macro that translates address codes abbreviated with an initial virgule (|) into their real form for use in a secondary merge file. Note that the specific codes and corresponding addresses must be entered by the user.

This is an excellent implementation of the {CASE CALL} command, which can branch into different subroutines and then return. The use of this command is more fully explained (with examples) in Appendix K of the documentation for *WordPerfect* 5.1 than it is in Mr. Dear's 5.0 manual. And since the programming language itself has been vastly expanded (including a wider use of variables) in the program's more recent version, I strongly recommend that you consider upgrading.

In the next column I'll describe a remarkable add-in that turns *WordPerfect* into the kind of program that users who like the convenience of command-driven operation can appreciate.

TIPS FROM WORKING WORDSMITHS

Tell fellow users about your latest word processing tips, and we'll pay you $50 for any tips we print. Please send your letter on a disk along with a printout. Mail your contributions to The Working Word, *PC Magazine*, One Park Avenue, New York, NY 10016, or upload them to PC MagNet (see the "By Modem" sidebar in the Utilities column). ■

by
Neil J. Rubenking

User-to-User

EASY PRINTER CONTROL

I find it convenient to force a printer to do a form feed without having to take my fingers from the keyboard. And when I print more than one file from the DOS command line, it's nice to be able to do a form feed between files without going to the printer.

ASCII character 12, created at the keyboard with ^L (Ctrl-L), causes a form feed when sent to the printer. It's what your word processing program sends when it wants to advance to a new page. You can send it yourself with the following line:

```
ECHO ^L > PRN
```

By the time you reach the printer, your final page will be waiting for you. Of course, you can put the line into a batch file, but I find it faster to simply type this little command myself when I need it.

Bob DuCharme
New York, New York

PC MAGAZINE The characters with ASCII values of less than 32 are often called *control characters*. Many of them have special functions in controlling devices, and you use the Ctrl key to enter them. Enter ECHO ^G at the DOS prompt and you'll hear a beep—^G is the bell character. Try holding down the Ctrl key and typing out the alphabet at the DOS prompt. Some of the keys will show on the screen, others won't, and still others will have a special effect. This last group is control characters for keyboard input. For example, ^H is a backspace, ^I is a tab, and ^J is a line feed.

Each printer has its own set of control codes for special actions like underlining or changing fonts, but almost every one recognizes ^L as a form-feed command. Depending on your printer, there may be other useful codes that you can send with the ECHO command. Many printers use ^O as the code for condensed printing and ^R as the code to end condensed printing. However, the more complex commands generally start with an Esc character, and you can't send that by typing an ECHO command—hitting Esc cancels your command. For serious printer control, look at *PC Magazine*'s SETUP2 utility. You can find it in the Utilities column in the May 30, 1989, issue, or download it from PC MagNet.

- EASY PRINTER CONTROL: Send a form feed to your printer without touching it.
- SINGLE-CHARACTER QUALIFIERS: Here's a surprising use of the forward slash.
- DEBUGGING BATCH FILES: Build a debug mode into your batch files.

SINGLE-CHARACTER QUALIFIERS

One use of the FOR command within batch files is to test user input. For example, in the lines

```
FOR %%a IN (H HELP h help) DO IF
 "%1" == "%%a" GOTO HELP
```

the command-line parameter "%1" is iteratively checked against H, HELP, h, and help. However, much of the punctuation character set, including the forward slash (/) and the question mark (?), cannot be checked in this manner.

A seemingly undocumented feature of the DOS batch processor allows the forward slash (/) to act as a single-character qualifier. So, whereas the batch lines

```
FOR %%a IN (H HELP h help ?) DO IF
 "%1" == "%%a" ECHO %1
```

would not normally be scanned beyond the fourth entry (help) in the set, if you insert a forward slash before the ? character, the command processor is able to recognize it. In the lines

```
FOR %%a IN (H HELP h help /?) DO
 IF "%1" == "%%a" ECHO %1
```

the single character ? would be processed properly.

The single-character qualifier also acts as a separator. The following batch command operates identically to the previous command:

```
FOR %%a IN (/HHELP/hhelp/?) DO IF
 "%1" == "%%a" ECHO %1
```

Characters qualified with a / separate other groups of characters, so there is no need to separate groups with a space. This can shorten long chains of characters such as upper- and lowercase drive letters. For example,

```
FOR %%a IN (/Aa/Bb/Cc/Dd/Ee) DO IF
 "%1" == "%%a:" GOTO DRIVEOK
```

tests for all upper- and lowercase disk drive designators between A: and E:.

Robert A. Trudo
Albuquerque, New Mexico

PC MAGAZINE Mr. Trudo's analysis is *almost* correct. The FOR command works in two distinct ways. If you just give it a set of character strings, it processes them in sequence, one at a time. But if any of those strings happens to be in the form of a filename with wildcards, it checks the disk for all matching files and processes each of *them*. Thus if there were any files with one-character names, the ? in the first example would cause the FOR loop to try each of them. If a file named A existed, then an input of A would trigger a call for help.

Try these two lines at the DOS prompt:

```
FOR %v IN (* ? /) DO ECHO %v
FOR %v IN (/* /? //) DO ECHO %v
```

The first line will echo any filenames that have no extensions, followed by any single-letter filenames. The second simply echoes an asterisk, a question mark, and a forward slash.

DEBUGGING BATCH FILES

I have a 15K batch file that automates building boot disks with different CONFIG.SYS and AUTOEXEC.BAT files, various utilities and editors, and reminder messages.

In normal operation, it reduces screen clutter by suppressing the display of most commands and messages. However, if a supposedly innocuous change to the file produces problems, there are few clues as to which statement caused the trouble.

Rather than modifying the file to display the necessary information, I set an environment variable before running the batch file:

```
SET DEBUG-IT=Yes
```

The batch file tests that variable and produces the information.

By extending this approach, you can enter commands *while* the batch file is running. That is, you don't have to think of all possibilities when you write the batch file. You can decide at runtime. You might choose commands that tell you what has happened so far, and based on that information, you might decide to terminate the batch file or continue.

DEBUGBAT.BAT and GETCOMND .BAT (Figure 1) show how to use these techniques to simplify debugging batch files.

James L. Gildersleeve
Payson, Arizona

We've all experienced making a minor change to a batch file and having it return nothing but "Syntax error." If the screen has been kept clear with ECHO OFF and lots of > NUL statements, it can take a fair amount of editing to put the batch file into a form that reveals exactly which line is causing the problem. When your work depends on a long and complex batch file, it's a great idea to build a debug mode into it.

GETCOMND.BAT is especially useful. Without leaving your batch file, you can run any commands you require to check the state of your system. You can even drop out to DOS by entering COMMAND. These additions will help make your large batch files more bulletproof.

To use the techniques from DEBUGBAT.BAT in your own files, copy the lines from the @ECHO OFF to the label :debug-b. These lines assign values to ECHO-IT and WHERE-TO. Add

```
@ECHO %ECHO-IT%
```

after that label and use it in place of any @ECHO OFF lines. Also find any occurrences of > NUL and replace them with > %WHERE-TO%. At strategic locations, add the lines that let you call GETCOMND to check out progress. And throw in any other informative displays that would help you in debugging. Your batch file will run a bit slower because of the extra IF tests and GOTOs, but it will be easier to maintain.

If you're using a DOS version earlier than 3.3, you will find it necessary to make the usual changes in these batch files, and note that the things you can do in GETCOMND.BAT are slightly limited. You aren't able to change the PROMPT or PATH, nor can you SET an environment variable. Any such changes would disappear as soon as the TEMPFILE.BAT file finished executing.

DEBUGBAT.BAT and GETCOMND.BAT — COMPLETE LISTING

```
::::: DEBUGBAT.BAT
@ECHO OFF
REM The start of the DEBUGBAT.BAT file.
IF '%DEBUG-IT%'=='Yes' GOTO debug-a
SET ECHO-IT=OFF
SET WHERE-TO=NUL
GOTO debug-b
:debug-a
SET ECHO-IT=ON
SET WHERE-TO=CON
:debug-b
@ECHO %ECHO-IT%
::::: Above lines set up the easy-debugging-info potential.

::::: Put the body of the batch file here.
ECHO Kilroy was here.  Pat Paulsen for president.

::::: For debugging, it might contain statements such as the following:
copy a:skeleton.bat b:autoexec.bat > %WHERE-TO%
IF NOT '%DEBUG-IT%'=='Yes' GOTO continue
::::: Get here when DEBUG-IT = Yes so can gather some debugging info.
DIR B:*.BAT
PAUSE IF OK, continue.  Or, use Ctrl-Break to quit at this point.

:continue
::::: Continue on with the batch file, and reach a place where you
:::::   might want to obtain some more debugging information.
IF '%DEBUG-IT%'=='Yes' CALL GETCOMND.BAT
::::: Continue on with the batch file.

::::: Following lines "erase" the environment variables.
SET DEBUG-IT=
SET ECHO-IT=
SET WHERE-TO=
REM The end of the DEBUGBAT.BAT file.

      ---------------------------------------------------

::::: This batch file, GETCOMND.BAT is called by DEBUGBAT.BAT.
::::: It was adapted from PC Magazine, January 31, 1989, page 279.

ECHO ON
REM The start of the GETCOMND.BAT file.
REM Enter your batch commands, which can be on several lines.
REM Then press Ctrl-Z and Enter to signal the end of your input.
COPY  CON  TEMPFILE.BAT
CALL       TEMPFILE.BAT
DEL        TEMPFILE.BAT
REM The end of the GETCOMND.BAT file.
```

Figure 1: These batch files illustrate how to get your batch files to produce debugging information. By calling GETCOMND.BAT, you can insert commands into a running batch file without halting it.

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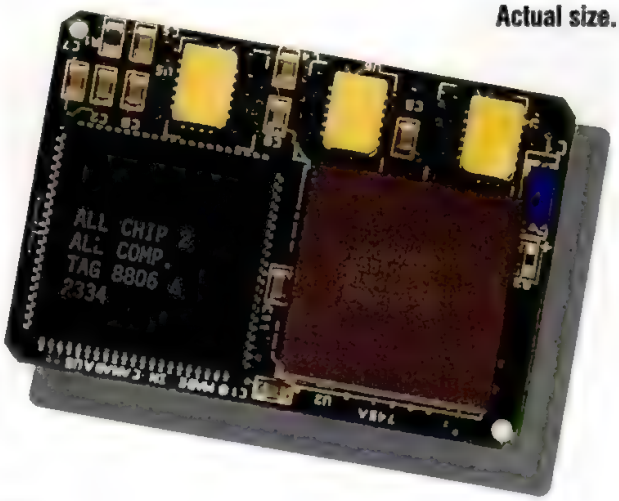

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edited by
Tony Rizzo

Languages

NUMBERS AS OBJECTS

Here is one of the results of my grappling with object-oriented programming in general, and with Turbo Pascal 5.5 in particular. My idea was to extend the numeric types to include rational and complex numbers. I also wanted to provide some compatibility between these types so that one could, for example, add a rational number to a complex number and get a complex number.

Two integers determine a rational number—its numerator and its denominator. Two real numbers determine a complex number—its real part and its imaginary part. Let's start by looking at the Rational object, near the top of NUMBERS.PAS, which is shown in Figure 1. We're using LongInts in our representation simply to increase the range of representable numbers. Furthermore, we require that n and d be reduced to lowest terms. The method Reduce does this by computing the greatest common divisor of n and d and dividing them by it.

> ■ NUMBERS AS OBJECTS: Use objects in Pascal to represent and manipulate rational and complex numbers.

The first problem is how to represent the arithmetic operations. Ideally, we would like to say

```
a := b.plus(c);
```

where a, b, and c are objects of type Rational. Unfortunately, a Pascal function (or method) cannot return a record (or object). At best, it can return a pointer to something. When this is the case, we will write statements such as

```
a := b.plus(c)^; {a=b+c}
a := b.times(c)^.plus(d)^;
 {a=(b*c)+d}
a := b.times(c.plus(d)^)^;
 {a=b*(c+d)}
```

which seems much more pleasant.

Now, however, now we encounter other problems—to be specific, where does "plus" get the pointer it returns, and how does that memory get deallocated when it's no longer needed? Our solution to these problems is to keep a storage pool of pointers. Whenever a method needs a pointer

NUMBERS.PAS 1 of 2

```
UNIT numbers;

(********************)
(**)  INTERFACE   (**)
(********************)

CONST POOLSIZE = 128;

TYPE
  NumberPtr = ^Number;
  NPPtr = ^NumberPool;
  Number = object
    np : NPPtr;
    CONSTRUCTOR init(iNp : NPPtr);
    DESTRUCTOR done;
    FUNCTION  im : Real; virtual;
    FUNCTION  re : Real; virtual;
    FUNCTION  equal(VAR nv : Number) : Boolean; virtual;
    FUNCTION  numer : Integer; virtual;
    FUNCTION  denom : Integer; virtual;
    PROCEDURE error(s : STRING);
    PROCEDURE cleanup;
    FUNCTION  GetPool : NPPtr;
  END;

  ComplexPtr = ^Complex;
  Complex = object(Number)
    a, b : Real;
    CONSTRUCTOR init(x, y : Real; iNp : NPPtr);
    CONSTRUCTOR initFrom(VAR nv : complex);
    CONSTRUCTOR ReadLn(iNp : NPPtr);
    DESTRUCTOR done;
    FUNCTION im : Real; virtual;
    FUNCTION re : Real; virtual;
    FUNCTION equal(VAR nv : Number) : Boolean; virtual;
    FUNCTION asString : STRING;
    FUNCTION plus(VAR nv : Number) : ComplexPtr;
    FUNCTION minus(VAR nv : Number) : ComplexPtr;
    FUNCTION times(VAR nv : Number) : ComplexPtr;
    FUNCTION divBy(VAR nv : Number) : ComplexPtr;
  END;

  RationalPtr = ^Rational;
  Rational = object(Number)
    n, d : LongInt;
    CONSTRUCTOR init(x, y : LongInt; iNp : NPPtr);
    CONSTRUCTOR InitFrom(VAR nv : Rational);
    CONSTRUCTOR ReadLn(iNp : NPPtr);
    DESTRUCTOR done;
    FUNCTION  re : Real; virtual;
    FUNCTION  im : Real; virtual;
    FUNCTION  equal(VAR nv : Number) : Boolean; virtual;
    FUNCTION  numer : Integer; virtual;
    FUNCTION  denom : Integer; virtual;
    FUNCTION  asString : STRING;
    FUNCTION  plus (VAR nv : Number) : RationalPtr;
    FUNCTION  minus(VAR nv : Number) : RationalPtr;
    FUNCTION  times(VAR nv : Number) : RationalPtr;
    FUNCTION  divBy(VAR nv : Number) : RationalPtr;
    PROCEDURE reduce;
  END;

  Pool = object
    p : ARRAY[1..POOLSIZE] OF NumberPtr;
    ixcur : 1..POOLSIZE;
    PROCEDURE init;
    PROCEDURE gc;
  END;

  NumberPool = object(Pool)
    FUNCTION newComplexPtr(x, y : Real) : ComplexPtr;
    FUNCTION newRationalPtr(x, y : LongInt) : RationalPtr;
  END;

(********************)
(**)IMPLEMENTATION(**)
(********************)

  PROCEDURE Pool.init; BEGIN ixcur := 1; END;

  PROCEDURE Pool.gc; {Garbage Collection}
  VAR i : Integer;
  BEGIN
    FOR i := 1 TO ixcur-1 DO Dispose(p[i],done);
    ixcur := 1;
  END;
  FUNCTION NumberPool.newComplexPtr(x, y : Real) : ComplexPtr;
  BEGIN
    p[ixcur] := New(ComplexPtr, init(x, y, @self));
    newComplexPtr := ComplexPtr(p[ixcur]);
    Inc(ixcur);
  END;

  FUNCTION NumberPool.newRationalPtr(x, y : LongInt) : RationalPtr;
  BEGIN
    p[ixcur] := New(RationalPtr, init(x, y, @self));
    newRationalPtr := RationalPtr(p[ixcur]);
    Inc(ixcur);
```

Figure 1: NUMBERS.PAS provides objects for performing calculations on rational and complex numbers.

NUMBERS.PAS 2 of 2

```
  END;

{************* Methods for Object: Number ************}

  constructor Number.init(iNp : NPPtr); BEGIN np := iNp; END;

  DESTRUCTOR Number.done; BEGIN END;

  PROCEDURE Number.error(s : STRING);
  BEGIN
    WriteLn('Error in class "Number": ', s);
    Halt(1);
  END;

  FUNCTION Number.im : Real; BEGIN error('im'); END;

  FUNCTION Number.re : Real; BEGIN error('re'); END;

  FUNCTION Number.numer : Integer; BEGIN error('numer'); END;

  FUNCTION Number.denom : Integer; BEGIN error('denom'); END;

  FUNCTION Number.equal(VAR nv : Number) : Boolean;
  BEGIN error('equal') END;

  PROCEDURE Number.Cleanup; BEGIN np^.gc; END;

  FUNCTIOn Number.GetPool : NPPtr; BEGIN GetPool := np; END;

  {************* Methods for Object: Complex ***********}

  CONSTRUCTOR Complex.init(x, y : Real; iNp : NPPtr);
  BEGIN a := x; b := y; Number.Init(iNp); END;

  CONSTRUCTOR complex.initFrom(VAR nv : Complex);
  BEGIN Init(nv.re, nv.im, nv.getpool); END;

  CONSTRUCTOR Complex.ReadLn(iNp : NPPtr);
  VAR s : STRING;
    p, q, err : Integer;
  BEGIN
    System.ReadLn(s);
    p := pos('+', s);
    IF p = 0 THEN
      BEGIN
        p := pos('-',Copy(S,2,pred(length(S))));
        IF p > 0 THEN inc(P);
      END;
    q := pos('i', s);
    IF (p = 0) THEN
      BEGIN
        IF q <> 0 THEN Fail;
        Val(s, a, err);
        IF err <> 0 THEN Fail;
        b := 0;
      END
    ELSE
      BEGIN
        IF q = 0 THEN Fail;
        Val(Copy(s, 1, p-1), a, err);
        IF err <> 0 THEN Fail;
        Val(Copy(s, p+1, q-p-1), b, err);
        IF err <> 0 THEN Fail;
      END;
    IF s[p] = '-' THEN b := -b;
    init(a, b, np);
  END;

  DESTRUCTOR Complex.done; BEGIN END;

  FUNCTION Complex.im : Real; BEGIN im := b; END;

  FUNCTION Complex.re : Real; BEGIN re := a; END;
  FUNCTION Complex.equal(VAR nv : Number) : Boolean;
  BEGIN equal := (a = nv.re) AND (b = nv.im); END;

  FUNCTION Complex.asString : STRING;
  VAR ret, s : STRING;
  BEGIN
     Str(a:1:2, ret); Str(abs(b):1:2, s);
     IF b < 0 THEN ret := ret+'-'+s+'i'
     ELSE ret := ret+'+'+s+'i';
     asString := ret;
  END;

  FUNCTION Complex.plus(VAR nv : Number) : ComplexPtr;
  BEGIN
    plus := np^.newComplexPtr(a + nv.re, b + nv.im);
  END;

  FUNCTION Complex.minus(VAR nv : Number) : ComplexPtr;
  BEGIN
    minus := np^.newComplexPtr(a - nv.re, b - nv.im);
  END;

  FUNCTION Complex.times(VAR nv : Number) : ComplexPtr;
  BEGIN
    times := np^.newComplexPtr(a * nv.re - b * nv.im,
                               a * nv.im + b * nv.re);
  END;

  FUNCTION Complex.divBy(VAR nv : Number) : ComplexPtr;
  VAR m2 : Real;
  BEGIN
    WITH nv DO m2 := re * re + im * im;
    IF (m2 = 0) THEN error('Attempt to divide by 0 in class Complex');
    divby := np^.newComplexPtr((a * nv.re + b * nv.im) / m2,
                               (b * nv.re - a * nv.im) / m2);
  END;
  {************* Methods for Object: Rational **********}

  CONSTRUCTOR Rational.init(x, y : LongInt; iNp : NPPtr);
  BEGIN
    IF (y = 0) THEN BEGIN
      WriteLn('Attempt to init Rational with zero denominator');
      Halt(1);
    END;
    n := x; d := y;
    reduce;
    Number.Init(iNp);
  END;

  CONSTRUCTOR Rational.InitFrom(var nv : Rational);
  BEGIN Init(nv.numer, nv.denom, nv.getpool); END;

  CONSTRUCTOR Rational.ReadLn(iNp : NPPtr);
  VAR s : STRING;
      p, err : Integer;
  BEGIN
    System.ReadLn(s);
    p := pos('/', s);
    IF (p = 0) THEN
      BEGIN
        Val(s, n, err);
        IF err <> 0 THEN Fail;
        d := 1;
      END
    ELSE
      BEGIN
        Val(Copy(s, 1, p-1), n, err);
        IF err <> 0 THEN Fail;
        Val(Copy(s, p+1, Length(s)), d, err);
        IF err <> 0 THEN Fail;
      END;
    init(n, d, inp);
  END;

  DESTRUCTOR rational.done; BEGIN END;

  PROCEDURE Rational.reduce;
  VAR g : LongInt;

    FUNCTION gcd(x, y : LongInt) : LongInt;
    VAR r : LongInt;
    BEGIN
      WHILE (y <> 0) DO
        BEGIN
          r := x MOD y;
          x := y;
          y := r
        END;
      gcd := x;
    END;

  BEGIN
    IF (d < 0) THEN BEGIN d := -d; n := -n; END;
    g := gcd(n, d);
    IF (g <> 0) AND (g <> 1) AND (g <> -1) THEN
      BEGIN
        n := n DIV g;
        d := d DIV g;
      END;
  END;

  FUNCTION Rational.re : Real; BEGIN re := n/d; END;

  FUNCTION Rational.im : Real; BEGIN im := 0;   END;

  FUNCTION Rational.numer : Integer; BEGIN numer := n; END;

  FUNCTION Rational.denom : Integer; BEGIN denom := d; END;

  FUNCTION Rational.asString : STRING;
  VAR t, u : STRING;
  BEGIN
    Str(n, t);
    IF (d <> 1) THEN
      BEGIN Str(d, u); t := t+'/'+u; END;
    asString := t;
  END;

  FUNCTION Rational.plus(VAR nv : Number) : RationalPtr;
  BEGIN
    plus := np^.newRationalPtr(n * nv.denom + d * nv.numer, d * nv.denom);
  END;

  FUNCTION Rational.minus(VAR nv : Number) : RationalPtr;
  BEGIN
    minus := np^.newRationalPtr(n * nv.denom - d * nv.numer, d * nv.denom);
  END;

  FUNCTION Rational.times(VAR nv : Number) : RationalPtr;
  BEGIN
    times := np^.newRationalPtr(n * nv.numer, d * nv.denom);
  END;

  FUNCTION Rational.divBy(VAR nv : Number) : RationalPtr;
  BEGIN
    IF (nv.numer = 0) THEN BEGIN
      WriteLn('Attempt to divide by 0 in class Rational');
      Halt(1)
    END;
    divby := np^.newRationalPtr(n * nv.denom, d * nv.numer);
  END;

  FUNCTION Rational.equal(VAR nv : Number) : Boolean;
  BEGIN
    equal := (n = nv.numer) AND (d = nv.denom);
  END;

END.
```

for a result, it simply takes the next item in the pool. The implementation of the storage pool is the simplest possible: an object with an array of pointers. The disadvantage of this arrangement is that the programmer has to worry about running out of space in the pool of pointers. The pool needs a garbage collector method that the programmer would periodically call.

The next step is to make these objects interact. What we want to do, for example, is to define the Plus method so that `x.plus(y)` makes sense for two complex numbers, two rational numbers, or x complex and y rational. When we declare the method

```
Complex.plus(y : sometype)
```

what type should y be? We need to define a new object called Number, of which Rational and Complex are descendants. Then Complex.plus can take an argument of the type Number and treat it in the appropriate way. The code for Complex.plus can initialize a pointer to a new object with real part `a + y.re` and imaginary part `b + y.im`, where Re and Im are methods understood by all Numbers.

For a Complex object, Re and Im are the real and imaginary parts; for a Rational object, Im is zero and Re is n/d. The code for Rational.plus will be similar, except that it will use methods Numer and Denom. These methods don't make sense for an arbitrary Complex object, so we don't define them! We declare Re, Im, Numer, and Denom as virtual methods in class Number, and we code them so that any call to them results in a call to method Error, which prints a message and halts. Thus, if we try to call r.plus(z), where r is Rational and z is Complex, we will end up calling z.denom. Since denom is not implemented for Complex objects, the method for Number objects will be executed, and it will give a corresponding error message.

You should notice that the parameter in each of the methods Plus, Minus, Times, and DivBy is declared as VAR. This is vital, because we really do want the address of the actual object being passed, rather than a copy. If we omitted the VAR, the compiler would cast the function argument to the Number type and pass the result to the method. Once inside the method, the code will have "forgotten" the type of the argument, and the methods that got called would be the Number methods—and this, of course, is not what we want at all.

There are a number of additions that could make these objects more useful. One could add the definitions of various transcendental functions to the Complex class. As an example, here is the definition of the complex cosine:

```
FUNCTION Complex.cos : ComplexPtr;
VAR e : Real;
BEGIN
  e := System.exp(b);
  cos := npool.newComplexPtr(
    0.5*System.cos(a)*(1/e+e),
    0.5*System.sin(a)*(1/e-e));
END;
```

Note that within the body of Complex.cos, we need to call the "real" cosine. In order to do this, we have to tell the compiler that we want the Cos function from the System unit and not the one we are currently defining; this is achieved by referring to it as System .cos.

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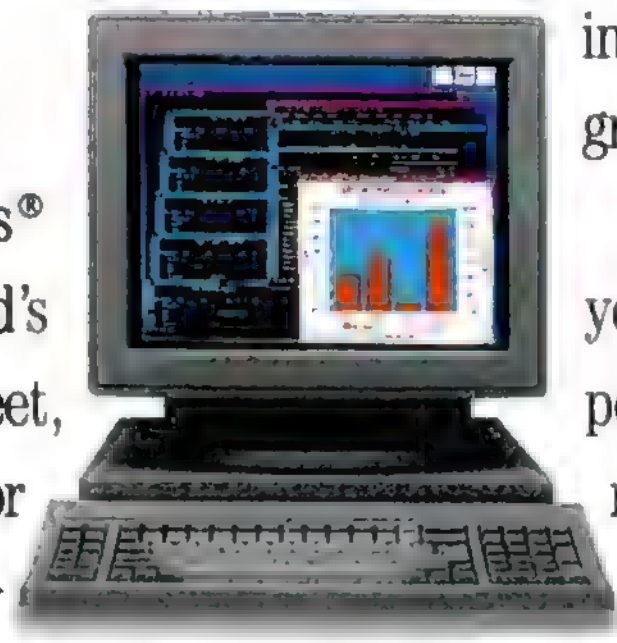

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The Rational example also points out a possible extension to TP5.5 that could be useful: the ability to choose whether methods (and data) are public or private. The Reduce method in Rational is really needed only by Rational, and it is not intended to be called by a user. But since we want it to be a method, we have to declare it in the type definition of Rational in the interface section, and so it is public.

Rob Torop
New York, New York

I made a few changes to NUMBERS.PAS to make it more thoroughly object-oriented. Instead of forcing all the operator functions to draw directly on a global pool for their pointers, I gave each number a pointer to the pool. Now it's possible to use local variables for the number pool, or to have more than one pool.

I also made the ReadLn method into a Constructor. When you think about it, it ought to be one—it initializes the object just as much as Init does. It happens to use values from the keyboard rather than values passed by another routine. But there's a potential problem, because the keyboard input may not be valid. Here a lesser-known feature of the Turbo Pascal Constructor comes into play—the Fail function. You can treat any Constructor as a Boolean function—it always returns true unless the Fail function gets called. If your program is allocating a pointer with the extended syntax of New, a call to Fail will make it deallocate the pointer and return NIL instead.

Note the InitFrom Constructor, too. In the text above, the author shows the line

```
a:=b.plus(c)^;
```

Perhaps this looks fine from a non-object-oriented standpoint, but it's really a booby trap. You cannot initialize the object "a" by a simple assignment statement—objects just don't work that way. It has to be initialized by a Constructor, or its link to the VMT won't be set up correctly. InitFrom initializes the object's data fields to match those of the object passed to it as a parameter.

The program NTEST (Figure 2) exercises the Rational or Complex number objects. It's hard-coded for Rational numbers, but if you change variables w through z to Complex, it will use complex numbers. Be warned—the math problems are a lot easier with rational numbers than with complex ones! Note also that every once in a while, NTEST will attempt to divide a complex number by another complex number whose real and imaginary parts are the same; this is equivalent to dividing by zero, and hence it activates the error routine.—*Neil J. Rubenking*

NTEST.PAS — COMPLETE LISTING

```
PROGRAM ntest;
  { Simple test of the Rational Class }
USES
  Numbers, CRT;

  PROCEDURE quiz;
  CONST OPS : ARRAY[0..3] OF Char = '+-*/';

  VAR
    x, y, z, w     : Rational;
    npool          : NumberPool;
    done           : Boolean;
    op             : Char;
    nQuest, score  : Integer;
  BEGIN
    Npool.Init;
    WriteLn;
    WriteLn('Hello.  I am Miss Helen Crump, your mathematics teacher.');
    WriteLn('Today we are going to have a surprise quiz on the arithmetic');
    WriteLn('of the field of Rational numbers.');
    WriteLn;
    Randomize;
    nQuest := 0;
    score := 0;
    REPEAT
      npool.GC;
      Inc(nQuest);
      WriteLn;
      x.init(Integer(Random(11)) - 5, Integer(Random(11)) - 5, @npool);
      y.init(Integer(Random(5)) + 1,  Integer(Random(5)) + 1,  @npool);
      op := OPS[Random(4)];
      CASE op OF
        '+' : z.InitFrom(x.plus(y)^);
        '-' : z.InitFrom(x.minus(y)^);
        '*' : z.InitFrom(x.times(y)^);
        '/' : z.InitFrom(x.divBy(y)^);
      END;

      Write(x.asString, ' ', op, ' ', y.asString, ' = ? ');
      REPEAT
        done := w.ReadLn(@npool);
        IF NOT done THEN Write(#7'Bad input format. Try again:');
      UNTIL done;
      IF w.equal(z) THEN
        BEGIN
          Inc(score);
          Write('     That is correct.  ')
        END
      ELSE
        WriteLn('     The correct answer is ', z.asString, '.   ');
      Write('Another (y/n)? ')
    UNTIL readKey = 'n';
    WriteLn;
    WriteLn('Your grade on the exam is ', 100*score/nQuest:3:0, '%.');
    IF (score/nQuest < 0.65) THEN
      WriteLn('You have disgraced yourself and your family.')
    ELSE
      WriteLn('You have passed.')
  END;

BEGIN
  clrScr;
  quiz
END.
```

Figure 2: NTEST uses the NUMBERS Unit to give you a test on math using rational or complex numbers.

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by
Jeff Prosise

Tutor

- ORDER OF PRECEDENCE: You'll have to compromise if you want DOS and OS/2 on the same hard disk.
- PRINTER TIME-OUTS: Here's how your programs can determine printer status.
- USING COM3 and COM4: It's not so easy to use the newer COM ports. Here's why.

ORDER OF PRECEDENCE

Help! I've installed OS/2, Version 1.2's high-performance file system on my hard disk, and now DOS won't recognize any part of the hard disk—including the DOS partitions. Would upgrading from DOS 3.3 to 4.0 help?

William Chamberlain
Austin, Texas

Formatting a partition for the high-performance file system doesn't necessarily preclude running DOS on the same hard disk. It's the order of the partitions that matters. If the DOS partition comes first, DOS will recognize it. If HPFS comes first, it won't.

During start-up, DOS scans the partition table in the first physical sector of the hard disk, looking for DOS partitions. When it encounters a non-DOS partition, it stops—even if it hasn't reached the end of the partition table. Any drive with partition-table entries that occur after this happens aren't recognized as valid drives.

The solution: rearrange your hard disk so that HPFS partitions come last. If you have four partitions assigned logical drive letters C: through F:, for example, make F: the HPFS partition. One drawback to this approach is that IBM's OS/2 installation program will install only OS/2 on drive C:, and some OS/2 system files won't work if they're located anywhere else. Finding out which files can't be transferred requires a time-consuming trial-and-error approach, because IBM doesn't document which files have to be where. In the end, the process is reduced to booting OS/2 from a FAT partition, booting DOS from a floppy disk (or using a dual boot), and making only partial use of HPFS. But it beats having to give up HPFS entirely—or worse yet, having to give up DOS.

Another solution, although not a practical one in most cases, is to maintain two separate hard disks—one for DOS and one for OS/2. Since physical drives don't share partition tables, you could format the DOS disk for the FAT file system and the OS/2 disk entirely for HPFS. You'd be restricted to the DOS disk while running DOS, but you could access either disk from OS/2. DOS programs that run in OS/2's DOS compatibility box enjoy full access to HPFS partitions.

Upgrading to DOS 4.0 won't help, because it suffers from the same limitations that 3.3 does when dealing with HPFS. However, DOS 4.0 offers an added advantage that Version 3.3 doesn't: the option of using FAT partitions greater than 32MB in length. DOS 4.0 and OS/2 support large FAT partitions, so with both systems on the same hard disk, you can mix and match partition sizes at will. With DOS 3.3, large partitions set up for OS/2 have to come after DOS partitions the same way HPFS partitions have to come after DOS partitions. It's the same problem over again—DOS 3.3 doesn't support large partitions, so it won't recognize anything in the partition table that comes after a large partition.

Could IBM have made it easier? It sure could have. Had OS/2 been designed so that it could boot from any partition, there would be no problem with putting DOS partitions first and saving HPFS for last. But for now, if you want both DOS and OS/2 to be on the same hard disk, you will have to compromise.

PRINTER TIME-OUTS

In an application program I'm developing, I need to control the amount of time that passes before a call to send a character to the printer with interrupt 17h times out. The technical reference I have says that LPT1 time-outs are controlled by the byte at address 0000:0078h. I checked five different PCs with varying configurations and found that all of them place the value 14h in this slot. Yet when I tested actual time-out intervals, they ranged from 20 seconds on an AT clone to 80 seconds on a 386SX-based Compaq PC. Even with the time-out value set to 1, the response still took several seconds. And when I tried setting it to 0, the call never timed-out at all.

What does the time-out value at 0000:0078h mean? Obviously it isn't the number of seconds that passes before the BIOS reports that a character can't be printed. Is there a way to gauge the readiness of a printer without having to wait several seconds to find out it won't accept a character?

Dennis Hampton
Oklahoma City, Oklahoma

The time-out value you place in the BIOS data area isn't a measure of how long the time-out interval will last in seconds, but an indicator of how many times the BIOS should try to print the character before giving up—times 65,536. In other words, with the default time-out value of 14h, the BIOS tries no fewer than 1,130,720 times to get a response from the printer. The number of seconds that this actually translates to depends on how tightly the interrupt 17h code in the BIOS is written, the speed of the PC, and how fast the parallel port can respond over the bus.

If you rely on the BIOS to time-out, setting the time-out value to 1 is the best you can do. Setting it to 0 makes matters worse. The BIOS decreases the time-out value by 1 and loops back for another 65,536 tries if the result isn't 0. Starting with a 0 ensures that the value is decremented to 255 the first time and results in a

total of almost 17 million tries before the BIOS gives up—far too long to wait.

There is a better way. A simple call to interrupt 17h with AH set to 2 and DX set to 0, 1, or 2 for LPT1, LPT2, or LPT3, respectively, will instantaneously return an array of six printer-status bits in AH that indicates when the printer is ready and when it's not. To gauge the effects that varying printer conditions have on this return value, create the utility PRSTAT .COM using the DEBUG script shown in Figure 1 and run it with your printer in various states—on, off, on but off-line, etc. PRSTAT.COM calls interrupt 17h, function 02h and displays the hex value returned in AH. The meanings of the individual status bits are diagrammed in Figure 2. You'll find that bit 3, the I/O Error bit, is a pretty reliable indicator that the printer is either off-line or powered-off. Likewise, if bit 5 is set, then the printer is out of paper. On the dot matrix and laser printers I tested PRSTAT on, bit 4 was always an accurate indicator of whether the printer was ready to accept a character. In assembly language, the simple code sequence

THE BIOS PRINTER STATUS BITS

Bit 7	Set if printer is not busy
Bit 6	Set on acknowledge
Bit 5	Set if printer is out of paper
Bit 4	Set if printer is selected (ready)
Bit 3	Set if an I/O error occurred
Bit 2	Not used
Bit 1	Not used
Bit 0	Set if printer is timed-out

Figure 2: Displayed here are the meanings of the bit settings that are returned in register AH when interrupt 17h, function 02h is called to determine the status of the printer.

```
MOV  AH,2
MOV  DX,0
INT  17H
TEST AH,10H
JZ   NOT_READY
 .
 .
 .
```

is enough to determine the status of the printer attached to LPT1 for most application programs. If you're writing in C, a code sequence similar to this one

```
regs.h.ah = 0x02;
regs.x.dx = 0x00;
if (!(int86(0x17, &regs, &regs)
 & 0x1000)) {
    printf("Printer not ready\n");
    exit(1);
}
 .
 .  /* Printer ready! */
 .
```

will accomplish the same result.

PRSTAT — **COMPLETE LISTING**

```
N PRSTAT.COM
A 100
JMP  0113
DB   "LPT1 Status: $"
DB   0D,0A,"$"
MOV  AH,9              ;Display "LPT1 Status:" message
MOV  DX,0102
INT  21
MOV  AH,2              ;Get status value
XOR  DX,DX
INT  17
PUSH AX                ;Display high nybble of AH
MOV  CL,4
SHR  AH,CL
CALL 013B
POP  AX
AND  AH,0F              ;Then display the low nybble
CALL 013B
MOV  AH,9
MOV  DX,0110
INT  21
MOV  AX,4C00             ;Exit
INT  21
ADD  AH,30               ;Subroutine to print a 4-bit
CMP  AH,39               ;  hex value
JBE  0146
ADD  AH,7
MOV  DL,AH
MOV  AH,2
INT  21
RET

RCX
4D
W
Q
```

Figure 1: This DEBUG script creates PRSTAT.COM, which you can use to display the printer status value returned in AH by interrupt 17h, function 02h.

USING COM3 and COM4

What's the deal with COM3 and COM4? Neither my mouse nor the MODE command will work with the third serial port in my system, but *ProComm* will. Is there something nonstandard about COM3 and COM4 that keeps them from working the same way COM1 and COM2 do?

Lewis A. Walls
New York, New York

You hit it right on the nose when you guessed that there was something "nonstandard" about COM3 and COM4. To drive a COM port, a program needs to know two things about it: what range of I/O addresses its UART registers are mapped to and what IRQ line it's connected to. The original IBM PC set the standard for COM1 and COM2 by assigning COM1 a base port address of 3F8H and interrupt line IRQ4 and by assigning COM2 a base address of 2F8H and IRQ3. No similar standard exists for COM3 and COM4.

In the absence of relevant standards, programs have to play a guessing game to find COM3 and COM4. Most hardware manufacturers that sell multiport I/O boards permit COM3 and COM4 addresses and interrupt levels to be custom-configured through DIP switch or jumper settings. Similarly, many application programs that deal with COM3 and COM4 let you specify serial port parameters through some type of setup routine. The challenge is to configure hardware and software to match.

DOS now comes with device drivers for COM3 and COM4 that assume COM3 is based at 3E8H and COM4 at 2E8H—exactly one paragraph below the corresponding addresses for COM1 and COM2. Some hardware manufacturers have

adopted these addresses as a semistandard, but support is far from universal. Moreover, DOS doesn't drive serial ports in interrupt mode, so it doesn't care what IRQ lines are used. Most communications programs do use UART interrupts, however, so a relevant standard must define interrupt levels in addition to I/O addresses.

In your particular system, *ProComm* works because it guesses correctly where to find COM3. DOS's MODE command doesn't, for one of two reasons: either COM3 isn't located at 3E8H (where DOS expects it to be), or you have a version of DOS that doesn't support more than two COM ports.

Interestingly enough, the POST in the PC BIOS checks only for two serial ports during start-up (it checks by reading the UART's Interrupt Identification register and checking for a valid value), yet there's room in the BIOS data area for information on four. In fact, if you care to poke the base address of COM3 or COM4 into the RS-232 address table found at offset 00H in the BIOS data area, the BIOS serial-port service routines accessed through interrupt 14H are geared to work with up to four serial ports.

> The original designers of the PC anticipated the need for more than two serial ports. PS/2s define I/O addresses and interrupt levels for up to eight serial ports.

Clearly, the original designers of the PC anticipated the need for more than two serial ports someday. PS/2s, in fact, define I/O addresses and interrupt levels for up to eight serial ports. But the I/O addresses for COM3 through COM8 require a Micro Channel–like bus that can decode 16-bit I/O addresses. Likewise, the PS/2 definition assumes that COM2 through COM8 can all share IRQ3. That's practical on a bus where interrupts are level-triggered (like the Micro Channel), but not on a standard AT bus, where interrupts are edge-triggered.

ASK THE TUTOR

The Tutor solves practical problems and explains points of general interest about using your hardware and software more productively, and answers basic questions about DOS and systems in general. In order to have your questions answered in this column, you should write to Tutor, *PC Magazine*, One Park Avenue, New York, NY 10016 or you can upload questions to PC MagNet (refer to the "By Modem" sidebar in the Utilities column). We're sorry, but we are unable to answer questions personally. ■

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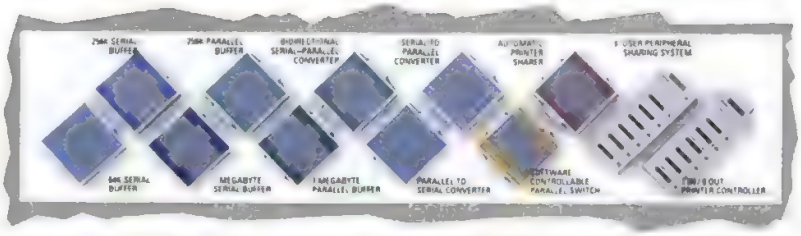

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CIRCLE 367 ON READER SERVICE CARD

by
Frank J. Derfler, Jr.

Connectivity

SHARING NONNETWORK DRIVES

We use PCs connected through an IBM Token-Ring Network running Novell's *NetWare*. Recently, we decided to take our accounting package off the network server for security and compatibility reasons. We installed it on the hard disk drive of one of the network client PCs.

The only problem with this current setup is that there are two people in the office who need to access the accounting software and database. Can you help us find either a software or a hardware solution that would allow us to share one person's hard disk among PCs?

Richard W. Graeber
Deerfield, Illinois

I'll assume that you want a PC to be able to access both the accounting software and the Novell server at the same time. The best way to do this is to set up the accounting software as a server running D-Link's *LANsmart* (see the review in this issue). But because you would also need the relatively expensive ($1,395) *LANmagic* package, this isn't the most economical approach.

A simple and economical approach to sharing resources among PCs on a Novell network is to use *Map Assist* from Fresh Technology Group (telephone: (602) 497-4200). *Map Assist* will allow you to share the hard disk drive that holds your accounting software. For more information, see the review of this $249-per-node package in the article "Networking CD-ROMs" in the February 27, 1990, issue of *PC Magazine*. *Map Assist* won't give you the throughput of *LANsmart* with *LANmagic* but it doesn't carry as high a price tag either.

CREATING A SUPER SERVER

We want to set up a server that will last for a few years and give super performance on our Novell network. What would you recommend?

Janice Parrish
Maynard, Massachusetts

- **SHARING NONNETWORK DRIVES:** Here's how to make the resources of one PC on a Novell network available to other PCs on the network.
- **CREATING A SUPER SERVER:** Three important factors to consider in setting up a super server.
- **LINKING NETWORKS:** You don't have to break down walls to connect two networks.
- **LINKING MACS AND PCs:** Here are three easy ways to connect PCs and Macs.

The super server question is one of the most common we receive. To create a nitromethane-rocket-powered super server, you need to consider three factors, in this order: hard disk performance, network adapter card throughput, and CPU performance.

The first thing to consider is hard disk drive performance. You'll want to purchase drives with seek times of 18 milliseconds or less that will format at a 1:1 interleave. Specify the drives and a controller with a fast ESDI interface. Our recommended combination is the CORE HC series of hard disk drives and 15-MHz controllers. CORE's HC100 gives a blazing 9-ms. seek time on a 100MB drive. CORE provides a 3-year full replacement warranty, so you know they believe in their products. Contact CORE at (407) 997-6055.

Since the CORE drives and controller have the capability of moving data at 1,500 kilobits per second—two to four times the typical operating speed of most LAN adapters—you must do something to avoid a bottleneck at the network interface card.

In our testing at the LAN Labs, we've seen significantly greater differences caused by the driver software provided with a particular network adapter board than among the adapter boards themselves. We noted this about a year ago when 3Com Corp. rewrote the drivers supplied by Novell for 3Com's EtherLink II boards, and created a great improvement in throughput.

Make sure you have the latest drivers for whatever adapter board and network software combination you use, or if you can, try boards from different manufacturers in the server. Some companies' programmers just know how to write faster drivers than others—that's the major way Artisoft gets such great throughput from *LANtastic*.

If you want to avoid adapter bottlenecks, you should get off the 16-bit AT-style bus and onto either the EISA or 32-bit Micro Channel bus. You must be able to use modern 32-bit adapters in your high-powered server. Frankly, we have not seen a consistent or significant difference in performance between EISA and MCA servers using comparable adapters. See the related feature story in this issue "Breaking I/O Bottlenecks with 32-bit LAN Adapters" for a description of the available 32-bit adapters for EISA and Micro Channel systems.

One easy way to avoid throughput bottlenecks at the adapter, particularly in ISA-bus machines, is to split the network and use two or more adapters in the same server. All network operating systems let you put at least two adapters in a server—*NetWare* accepts four. Use inexpensive network-monitoring packages like Brightwork Development's *E-Monitor* for Ethernet and *ARCmonitor Plus* for ARCnet (telephone: (800) 552-9876) to check the level of network traffic. If the network runs over 25 percent of network system

capacity—and a half dozen fast, busy 80386 machines can do that—try splitting the network cable and using two adapters in the server.

You'll find the phrase *client-server computing* in literature from Microsoft, IBM, Novell, and 3Com. The trend today is to load more services like database retrieval programs and network management utilities into the file server. Modern 386-based file servers run utilization rates of 40 to 50 percent under heavy loads, so in theory they have plenty of power left for server-based processes. But if you want a server with real longevity, then it's worthwhile to invest in a 486 processor.

An interesting alternative to consider is the Mylex 4DMAE replacement motherboard. For $7,600, you get an EISA motherboard with a 25-MHz 486 processor and 4MB of RAM. Armed with only a screwdriver, you can slip this high-horsepower board into an old PC AT cabinet in about 15 minutes. Mylex has done a lot of work with EISA, and we plan to use its motherboard and adapters in a LAN Labs "super-AT" server. Contact Mylex at (800) 446-9539 for more information on its EISA products.

LINKING NETWORKS

We need to link two Ethernet LANs separated by a solid wall. The buildings in our university are old and historic. There aren't any wiring ducts, and we get a lot of opposition to making holes in the granite and marble walls. Any ideas?

Al Williams
New York, New York

You didn't specify what networking software you use, but these ideas should help you link almost any type of network. First, stop thinking that the shortest distance between two points is a straight line. How does the local telephone company link both offices? They use wiring that goes to a common telephone closet somewhere. You'll probably have to pull one run of real twisted-pair (not the old standard telephone brown "quad" 4-wire) cable from each room to the telephone closet. If you marry that cable to a pair of the new 10Base-T twisted-pair Ethernet adapters, you can link the servers at 10 megabits per second.

Many companies make the 10Base-T cards. Alternatively, you can simply add an external transceiver, available from such companies as SynOptics Communications (telephone: (415) 960-1100), Optical Data Systems (telephone: (214) 234-6400) and many others. You'll also need a twisted-pair hub in the wiring closet.

Here's another, more exotic solution. Agilis Corp. (telephone: (415) 962-9400) sells rugged handheld AT-compatible computers for special field applications. An important feature of these machines is a built-in spread-spectrum Ethernet attachment.

The first spread-spectrum systems were used by the Department of Defense and other government agencies for reliable and practically undetectable communications. In this technology, the radio signal is spread over hundreds of megahertz. Normal receivers can't find it and neither natural noise sources nor man-made jammers usually affect it.

> If you want a server with real longevity, then it's worthwhile to invest in a 486 processor.

The Agilis spread-spectrum system operates at about 900 MHz, near the cellular telephone frequencies. The signal is spread enough to avoid interference from spot RF noise sources. These systems don't use enough bandwidth to support the full 10 megabits per second of Ethernet, but you get enough throughput for terminal operations.

The Agilis workstations operate as handheld or vehicle-mounted terminals in warehouses, factories, battlefields, and burning forests. They link together into a host Ethernet network over a spread-spectrum radio link. Agilis can supply you with the radio-link portion of the workstation complete with thin Ethernet adapters and power supply.

You could link your two LANs, as well as several others, by equipping each with an Agilis spread-spectrum radio. Agilis has software for 3Com's *3+Share*, NetBIOS, and TCP/IP links.

LINKING MACS AND PCs

I've got both a Macintosh and an IBM PS/2 Model 80 on my desk. I know how to move files on diskettes between the Mac and the Model 80, but it's a hassle. Is there an easy way to link these machines?

Peter Baldwin
Albany, New York

There are several alternatives for linking PCs to Macs and, as always, you get what you pay for. At the high end, in terms of both performance and price, you can set up a *NetWare* server and attach both machines with either Token-Ring or Ethernet. Figure a hefty $4,000 to $5,000 for this solution, but you'll get great capabilities including the ability to run database programs against the same data files on the server and, of course, an easy way to exchange files.

The *TOPS* networking software will work over Ethernet on the Model 80's MCA bus, so *TOPS* is a good solution that will give you file sharing between machines and allow you to use the Apple LocalTalk compatible printers. A two-station *TOPS* installation including the adapters will run about $1,000. *TOPS* actually gives you a few more Mac-to-PC specific features than *NetWare*, but with slower throughput and less potential for future expansion.

There is a third solution that doesn't provide the capabilities of the others, but it is cheap ($189.95) and easy: *Lap-Link Mac* from Traveling Software. This package connects PC and Macintosh computers through their serial ports. The software doesn't provide virtual drive capabilities, but the PC can get files from the Mac while the *Lap-Link Mac* software runs in background mode on the Mac. The *Lap-Link Mac* Connectivity Pac includes the cables you need as well as the software. For more information you can call Traveling Software at (206) 483-8088.

NETWORK YOUR QUESTIONS

Connectivity gives you practical solutions to networking problems of all types. We'll pay $50 for any tips we print. Please submit your letter on a disk along with a printout. Then mail your contributions to Connectivity, *PC Magazine*, One Park Avenue, New York, NY 10016, or you may contact Frank J. Derfler, Jr., via MCI Mail (be sure to use Derfler's box named PC MAGAZINE LAN LABS). We're sorry, but we're unable to answer letters personally. ■

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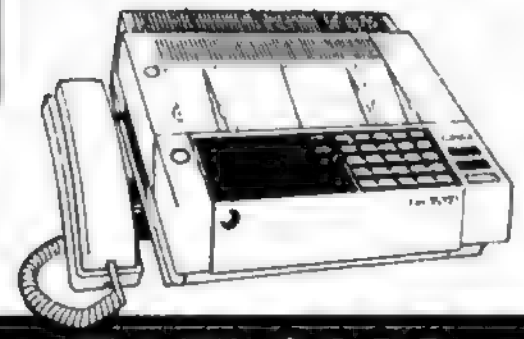

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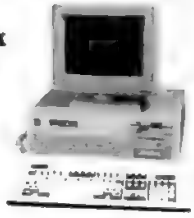

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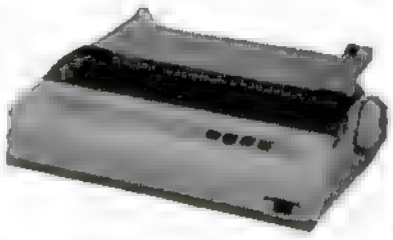

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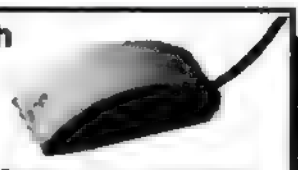

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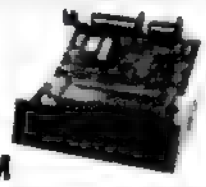

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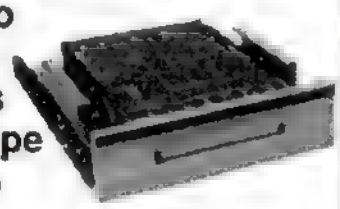

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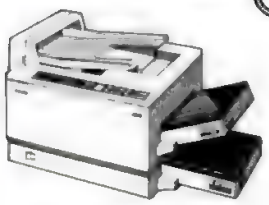

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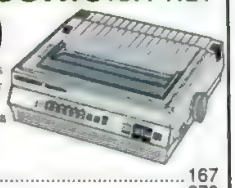

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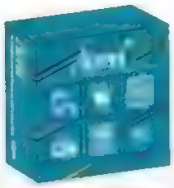

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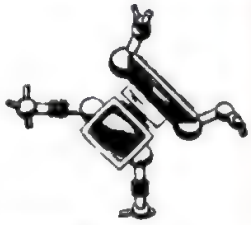

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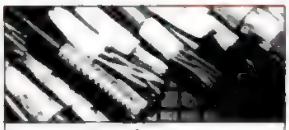

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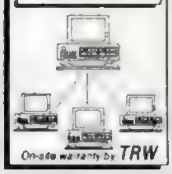

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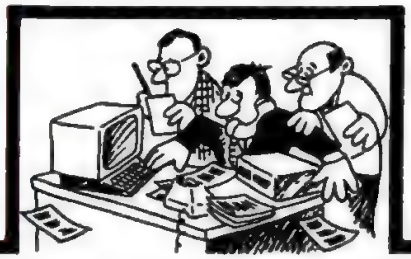

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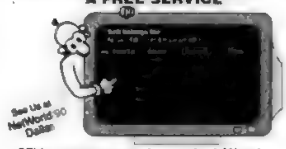

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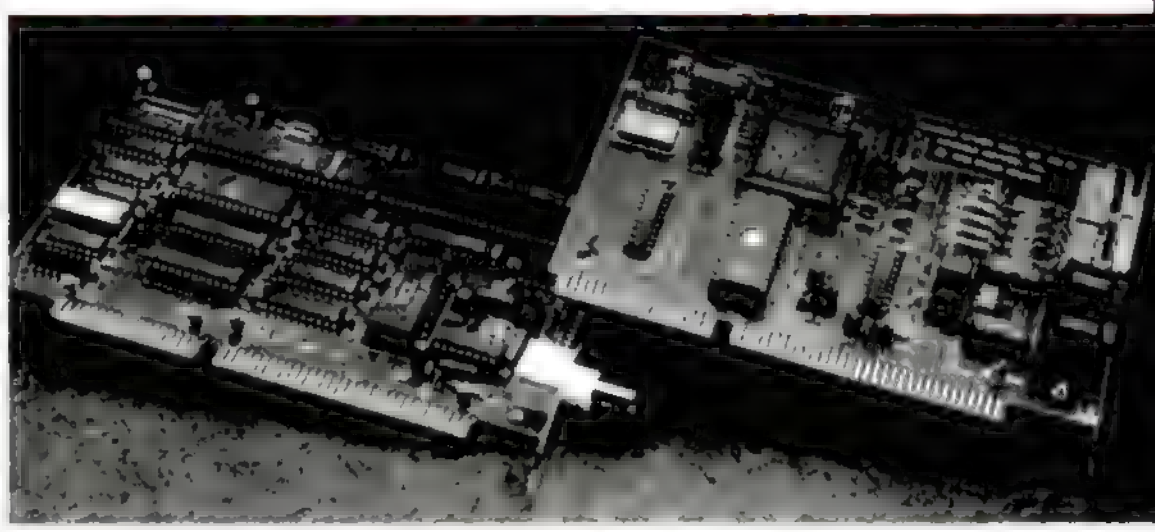

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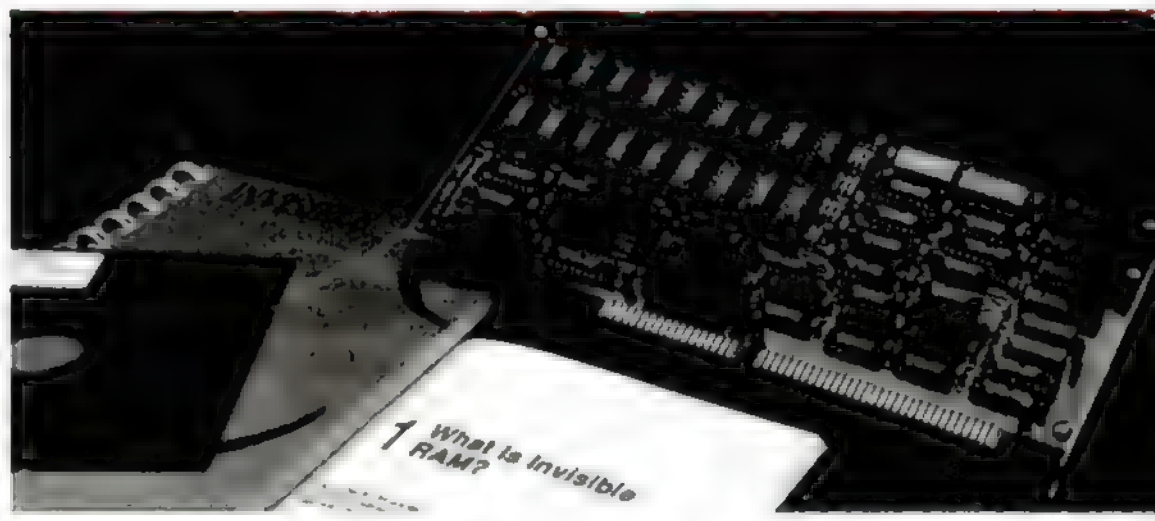

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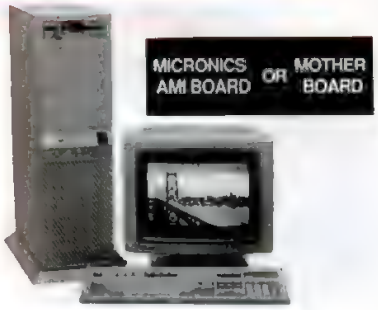

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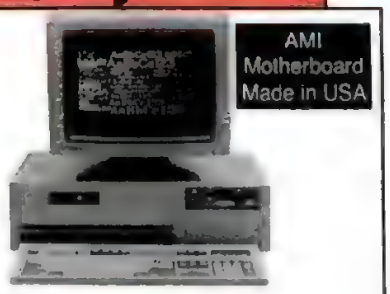

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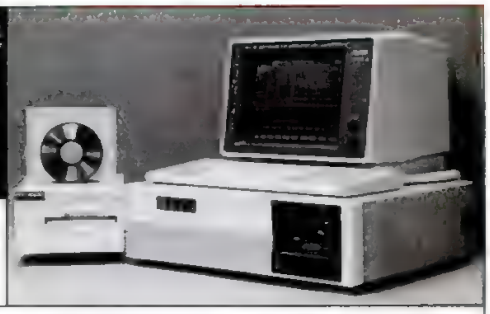

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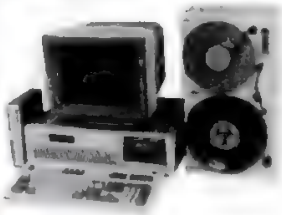

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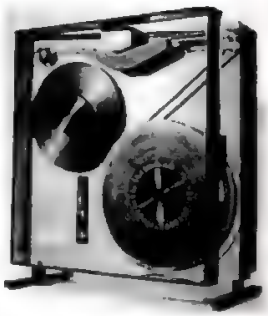

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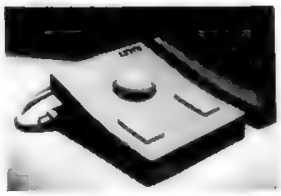

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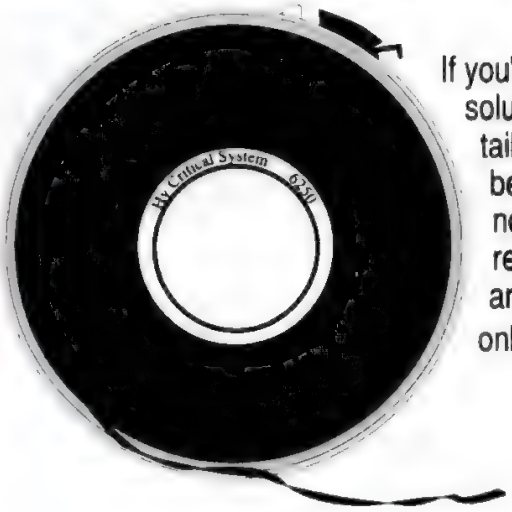

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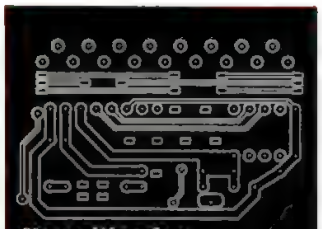

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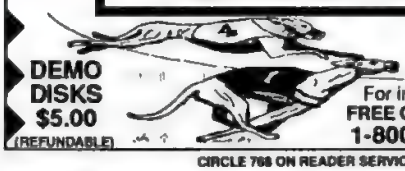

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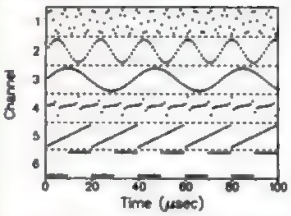

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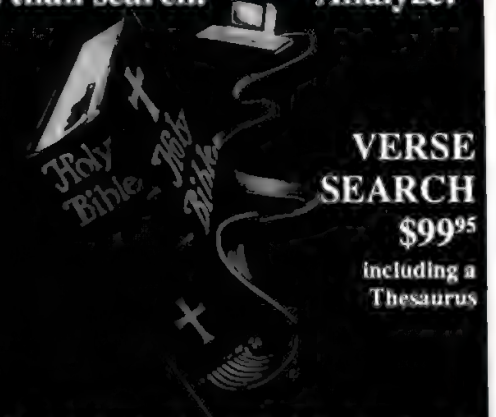

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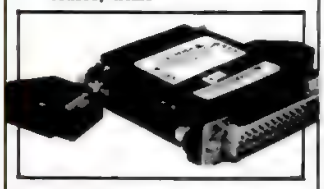

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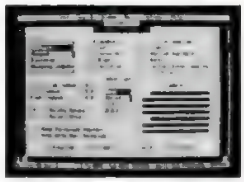

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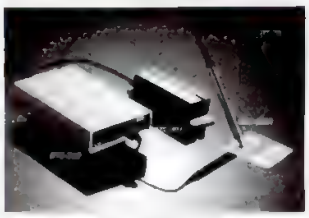

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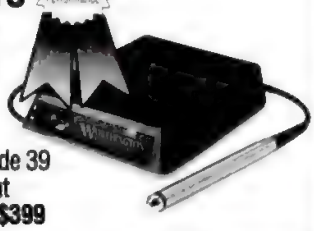

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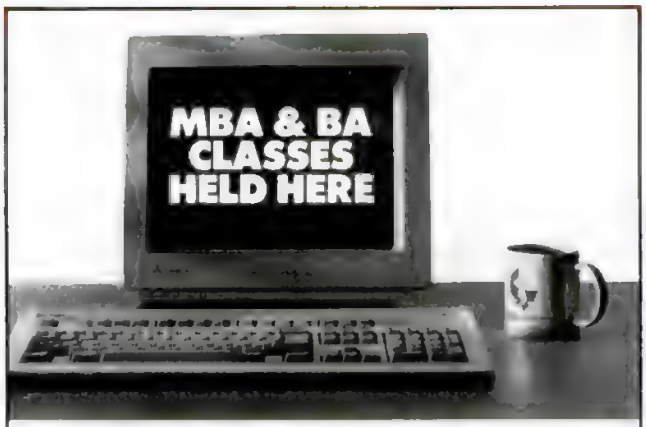

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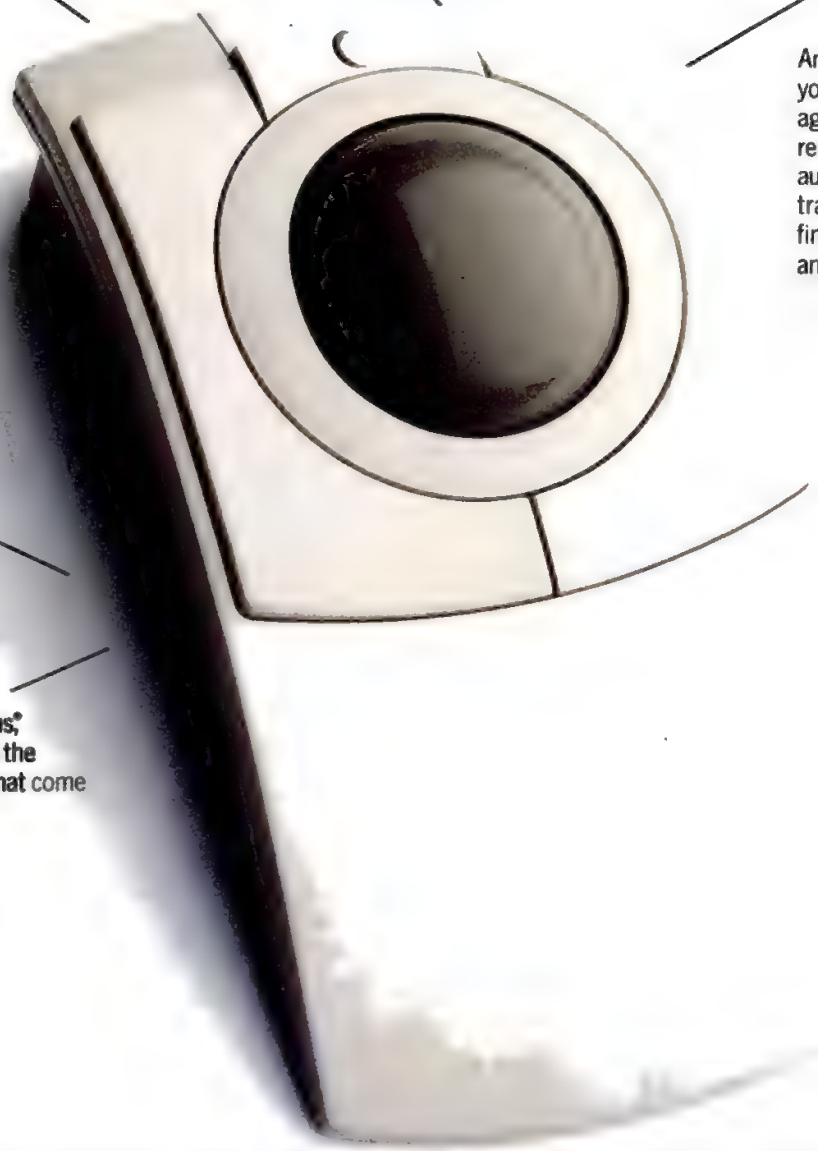

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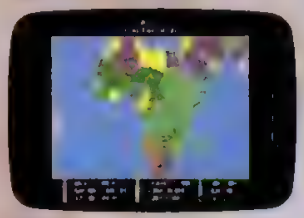

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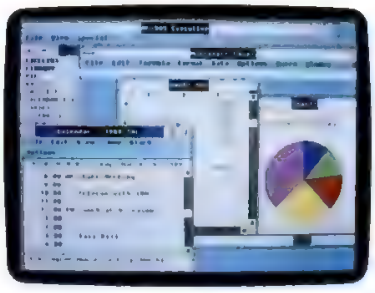

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Abrams Tank

CONTINUED

campaign, you must complete all eight missions, with all the settings selected by chance. Here again, you cannot save a particular battle until you've completed it. However, I did find that I could just turn off the computer if I needed to leave midbattle. This nullifies the current battle, though, and you must repeat it later to complete the campaign.

You control the tank from four locations: the gunner's station, the tank commander's station, the cupola, and the driver's station.

From the command post, you can pan the horizon 360 degrees to keep a watchful eye on hostile forces, and check your position on your MSP as you move across the multiterrained battlefield. You also have ready access to the tank's vital statistics: fuel level, engine temperature and, most important, damage.

If there is beauty in war, however, you will find it in the gunner's station, where your highly sophisticated thermal sighting and laser guidance system make blowing away the commie aggressors as easy as target practice.

You press a button and the guidance system locks onto the most immediate target, identifies it, and tells you the range and your chance of hitting it. Press another button and watch your target collapse into rubble.

If you are skilled and lucky enough to complete a campaign, you receive a final military ranking and a newspaper report describing the outcome of the war.

What makes this game so appealing is its colorful realism. The tank moves and fires in real time. It jostles when you speed up, stop, enter, or leave the road, or—heaven help you—get hit by an enemy shell. And your three-dimensional outer world is just as flush with details. Hills, mountains, streams, bridges, and farms await your every turn, not to mention hostile Soviet forces.

As with many modern games, you need at least a 286 processor and EGA graphics to effectively play *Abrams Battle Tank*. I tried playing on an IBM XT, but it was far too slow. And with CGA graphics, enemy tanks are just too difficult to see. In EGA resolution, the world is real. Play this game on a 386 with VGA and you'll feel like you're really there.

The succinct manual offers excellent help for getting started quickly. And unlike many simulators, *Abrams Battle Tank* is easy to learn. After two or three scenarios, you should be a proficient commander.

The downsides are few. *Battle Tank* lacks the incredible level of detail that Microprose crams into *M1 Tank Platoon*, and its modest manual doesn't begin to compete with the tome that Microprose gives you. I'd like to be able to save a scenario in midbattle, and I wish that individual missions differed in terrain and enemy placements each time you played them.

I also wish the other U.S. tanks could take a more active part in the battles, rather than blindly roaming the battlefields while Soviet crews rip holes in the sides of your tank. Here again, Microprose gets points for allowing you to control any of the individual tanks in a platoon instead of just one tank.

List Price: *Abrams Battle Tank*, $39.95. **Requires:** 512K RAM, graphics adapter, DOS 2.0 or later. Electronic Arts, 1820 Gateway Dr., San Mateo, CA 94404; (800) 245-4525, (415) 571-7171.

CIRCLE 405 ON READER SERVICE CARD

From the *Battle Tank* command post, your MSP tracks your battlefield position.

The gunner's position in *Battle Tank* gives you access to most tank controls and vital statistics.

Object-Oriented Cartooners Builds Simple Animations

Education
By Robin Raskin

You don't truly appreciate the art of animation until you create your own moving picture, whether it's a paper flip book or an electronic movie. *Cartooners*, a software package from Electronic Arts, gives you one of the most moving introductions I can imagine. This software is obviously targeted at kids, but don't be surprised if you find yourself hooked on it, too.

The program lets you piece together background scenes, whimsical actors, props, canned music, and canned movements to make a colorful on-screen comic strip. A varied assortment of speech balloons like the ones you see in comic strips breathe dialogue (as well as titles and credits) into animation.

The program is stupendously object oriented; each actor has his own repertoire of movements. The basic idea is to select a background scene (there are farms, forests, and even graveyards) and then populate it with your actors and props. You endow movement via a series of pull-down menus that let you choose the direction and the type of movement for a character.

Then, click on the record button and your actors start to move. Use the forward and reverse buttons to dub-in a little canned music (spooky, happy, "doinks," and more) and you've got yourself a cartoon. Bunnies are hopping, eyes are popping, wolves are grabbing, and you are recording it all for posterity. You can stop recording and bring elements into or out of the production at any time.

The possibilities are enormous. You can create multiple copies of a character, turn a black-and-

CONTINUES

Cartooners

CONTINUED

white text speech balloon into a color-text thought balloon, make a character walk behind or in front of a bush, speed up the animation, or insert a meaningful silent pause. Editing tools for marking a series of frames, and cutting, pasting, or copying them are all available.

Even those too young to animate can play with the program in the LOOK mode, where they click on ticket icons that launch stored animations. And printed copies of the animations make great comic books.

Of course, programs like these supply the basic elements: actors, backgrounds, music, and movements. Electronic Arts bundles a supplemental outer-space theme disk with added characters and music, and you can use *Deluxe Paint II* to create additional backgrounds and elements (you can't make them move, however) for import. Animations have a reasonable size limitation of 2,000 frames, but there's a serious relationship between the complexity of animation and the speed of the playback.

My own test-bed of young animators (ages 3 to 12) had a ball with the program. They became adept at handling the involved sequence of pull-down menus and the process of building an animated scene. They decided that *Cartooners* was "even better than Broderbund's FantaVision," a program that teaches more animation skills, such as tweening, but it doesn't offer canned art and is more difficult to master.

Only the oldest and most motivated in the crowd, however, were able to stick with the tedious process of refining a cartoon. But that's okay; that left me a lot of time to play by myself. ■

Cartooners supplies predrawn characters and background scenes from which to construct animations.

List Price: *Cartooners*, $49.95.
Requires: 512K RAM, color monitor and color adapter card, Microsoft-compatible mouse, DOS 2.0 or later. Printers and sound boards (CMS Board, Ad Lib Board, Roland MT32 Board or LAPC) are optional but fun.
Electronic Arts, 1820 Gateway Dr., San Mateo, CA 94404; (800) 245-4525, (415) 571-7171.

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#-Regional Advertisement.

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by Bill Howard

Abort, Retry, Fail?

The Lighter Side of Personal Computing

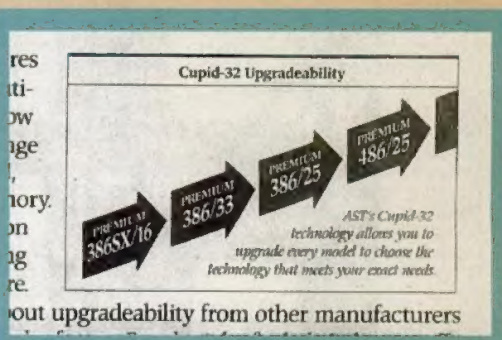
Joe Average User only gets 95 keys? Even though ads can be prone to overstatement (and we're charitably disregarding that the keyboard photo is backward), isn't it a bit of a reach for this ad in the 1990 JDR Microdevices catalog to declare 101-key keyboards are "just right for the power user!"

The Experts Explain the Relationship Between RAM and Your Hard Disk...

"In any case it is best to outfit computers with sufficient operating memory.... Storage memory or random access memory (RAM) will require a hard disk drive, which can be internal or external, and is available in increments of 20, 40, 80 Mbytes and up. The RAM figure limits the amount of data stored on the hard disk drive. Since this is the data available for processing by the computer and software, I suggest you buy a hard disk drive with more RAM memory than you expect to require."
—*Photomethods*, June 1989

The Experts Further Explain the Relationship...

"RAM: Random Access Memory — found on disks. Think of RAM as a big storage blackboard that can be added to, edited and erased in random, rather than sequential order."
"K: Stands for 1,000 and expresses the number of 'bytes' or size of a computer's built-in memory, and its capacity for storing information. Numbers generally increase in 64K increments because the memory capacity of most individual chips is 64K."
—*The Sacramento* (California) *Bee Magazine*, January 21, 1990



Note the upward path defined by AST Research in this ad for its Cupid-32 upgradable processor technology.

...Having Described RAM and Hard Disks, the Experts Offer a Ballpark Estimate of Your Home-Computing Needs

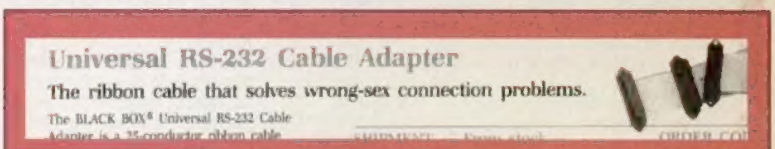
"Megahertz (Mhz): An expression of the speed at which the CPU processes information and commands. The home user generally doesn't need anything above a range of from 8 to 33 megahertz."
—*The Sacramento* (California) *Bee Magazine*, January 21, 1990

creates a marked-up copy of your original document with comments pointing out errors in grammar, style, word usage, and punctuation. These comments are the your guide to better writing.

System Requirements

384K memory with two dual sided diskette drives, or one diskette drive and hard disk.

Ad for RightSoft's RightWriter, the self-described "expert system for pointing out problems in grammar, style, word usage, and punctuation."



Technically, that's what gender-changer cables do. But we've never heard the issue discussed as frankly as in this Black Box Corp. catalog (January 1989). Dr. Ruth would be proud.

Receive a *PC Magazine* T-shirt and $50 if we use your submission in Abort, Retry, Fail. Winners this issue: Marcio Paulino (AST Cupid-32), Deo Maynard and Norman Meyer (RightWriter), Preston Gralla (wrong-sex connections), Harry O'Connell (power keyboard) Mark Iocolano (RAM and hard disks), Douglas Thompson (RAM, MHz defined).

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